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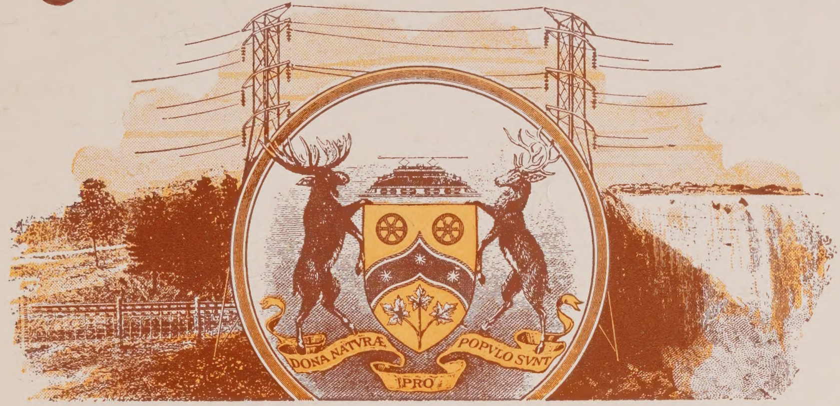
Ontario. Hydro-Electric Power Commission
Hydro news

# The BULLETIN




Hydro-Electric Power Commission of Ontario

Volume XXV — JANUARY - DECEMBER, 1938 — Number 1 - 12

Vol. 25-26 (1938-1939)

*One hundred and ten thousand volt, double circuit tower line in Don valley, Prince Edward viaduct in background.*

# *Municipal Loads, November, 1938*

NIAGARA SYSTEM

25 Cycle

| | H.P. | Population |
|---|---|---|
| Acton | 977 | 1,993 |
| Agincourt | 175 | P.V. |
| Ailsa Craig | 119 | 452 |
| Alvinston | 93 | 643 |
| Amherstburg | 881 | 2,879 |
| Ancaster Twp. | 377 | V.A. |
| Arkona | 59 | 415 |
| Aurora | 1,210 | 2,758 |
| Aylmer | 720 | 1,995 |
| Ayr | 194 | 770 |
| Baden | 351 | P.V. |
| Beachville | 431 | P.V. |
| Beamsville | 420 | 1,208 |
| Belle River | 163 | 748 |
| Blenheim | 531 | 1,755 |
| Blyth | 107 | 624 |
| Bolton | 177 | 569 |
| Bothwell | 127 | 642 |
| Brampton | 2,764 | 5,568 |
| Brantford | 15,150 | 31,232 |
| Brantford Twp. | 791 | V.A. |
| Bridgeport | 124 | P.V. |
| Brigden | 82 | P.V. |
| Bronte | 176 | P.V. |
| Brussels | 136 | 787 |
| Burford | 165 | P.V. |
| Burgessville | 49 | P.V. |
| Caledonia | 343 | 1,370 |
| Campbellville | 34 | P.V. |
| Cayuga | 135 | 674 |
| Chatham | 6,363 | 15,910 |
| Chippawa | 301 | 1,187 |
| Clifford | 81 | 441 |
| Clinton | 506 | 1,865 |
| Comber | 167 | P.V. |
| Cottam | 80 | P.V. |
| Courtright | 47 | 286 |
| Dashwood | 80 | P.V. |
| Delaware | 62 | P.V. |
| Delhi | 540 | 1,701 |
| Dorchester | 122 | P.V. |
| Drayton | 115 | 566 |
| Dresden | 378 | 1,468 |
| Drumbo | 93 | P.V. |
| Dublin | 86 | P.V. |
| Dundas | 1,887 | 4,757 |
| Dunnville | 1,150 | 4,001 |
| Dutton | 254 | 776 |
| Elmira | 721 | 2,063 |
| Elora | 366 | 1,138 |

| | H.P. | Population |
|---|---|---|
| Embro | 111 | 449 |
| Erieau | 64 | 238 |
| Erie Beach | 12 | 26 |
| Essex | 460 | 1,798 |
| Etobicoke Twp. | 6,463 | V.A. |
| Exeter | 485 | 1,629 |
| Fergus | 1,055 | 2,785 |
| Fonthill | 128 | 803 |
| Forest | 455 | 1,586 |
| Forest Hill | 7,564 | 9,147 |
| Galt | 7,618 | 14,119 |
| Georgetown | 1,331 | 2,189 |
| Glencoe | 194 | 778 |
| Goderich | 1,252 | 4,336 |
| Granton | 60 | P.V. |
| Guelph | 10,223 | 21,455 |
| Hagersville | 404 | 1,345 |
| Hamilton | 103,340 | 154,020 |
| Harriston | 353 | 1,273 |
| Harrow | 397 | 918 |
| Hensall | 174 | 719 |
| Hespeler | 1,999 | 2,861 |
| Highgate | 73 | 327 |
| Humberstone | 424 | 2,563 |
| Ingersoll | 2,470 | 5,139 |
| Jarvis | 187 | 504 |
| Kingsville | 625 | 2,282 |
| Kitchener | 20,674 | 32,650 |
| Lambeth | 149 | P.V. |
| LaSalle | 219 | 782 |
| Leamington | 1,618 | 5,340 |
| Listowel | 1,039 | 2,819 |
| London | 36,737 | 73,091 |
| London Twp. | 570 | V.A. |
| Long Branch | 1,121 | 4,099 |
| Lucan | 188 | 613 |
| Lynden | 93 | P.V. |
| Markham | 344 | 1,112 |
| Merlin | 81 | P.V. |
| Merritton | 5,689 | 2,543 |
| Milton | 1,098 | 1,785 |
| Milverton | 374 | 987 |
| Mimico | 2,827 | 6,876 |
| Mitchell | 521 | 1,577 |
| Moorefield | 31 | P.V. |
| Mount Brydges | 95 | P.V. |
| Newbury | 40 | 276 |
| New Hamburg | 499 | 1,464 |
| Newmarket | 1,512 | 3,526 |
| New Toronto | 7,027 | 6,848 |
| Niagara Falls | 10,134 | 18,747 |

| | H.P. | Population |
|---|---|---|
| Niagara-on-the-Lake | 477 | 1,563 |
| Norwich | 385 | 1,174 |
| Oakville | 1,094 | 3,868 |
| Oil Springs | 212 | 472 |
| Otterville | 115 | P.V. |
| Palmerston | 484 | 1,410 |
| Paris | 1,369 | 4,315 |
| Parkhill | 183 | 997 |
| Petrolia | 1,070 | 2,720 |
| Plattsville | 81 | P.V. |
| Point Edward | 1,265 | 1,252 |
| Port Colborne | 2,080 | 6,196 |
| Port Credit | 817 | 1,755 |
| Port Dalhousie | 655 | 1,459 |
| Port Dover | 364 | 1,665 |
| Port Rowan | 83 | 666 |
| Port Stanley | 296 | 741 |
| Preston | 2,997 | 6,294 |
| Princeton | 103 | P.V. |
| Queenston | 124 | P.V. |
| Richmond Hill | 429 | 1,268 |
| Ridgetown | 554 | 1,983 |
| Riverside | 1,062 | 5,017 |
| Rockwood | 116 | P.V. |
| Rodney | 180 | 724 |
| St. Catharines | 14,012 | 26,834 |
| St. Clair Beach | 76 | 100 |
| St. George | 138 | P.V. |
| St. Jacobs | 296 | P.V. |
| St. Marys | 1,401 | 4,023 |
| St. Thomas | 8,024 | 16,088 |
| Sarnia | 8,991 | 18,230 |
| Scarborough Twp. | 4,114 | V.A. |
| Seaforth | 533 | 1,717 |
| Simcoe | 2,251 | 5,614 |
| Smithville | 285 | P.V. |
| Springfield | 61 | 365 |
| Stamford Twp. | 2,435 | 7,842 |
| Stouffville | 237 | 1,155 |
| Stratford | 7,008 | 17,555 |
| Strathroy | 1,196 | 2,911 |
| Streetsville | 152 | 636 |
| Sutton | 176 | 831 |
| Swansea | 2,890 | 5,504 |
| Tavistock | 552 | 1,034 |
| Tecumseh | 304 | 2,432 |
| Thamesford | 199 | P.V. |
| Thamesville | 229 | 788 |
| Thedford | 130 | 585 |
| Thorndale | 64 | P.V. |

# THE BULLETIN

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# "Hydro" Progress in 1937

By Dr. Thomas H. Hogg, Chairman, The Hydro-Electric Power Commission of Ontario

EXPANSION in the Northern Ontario field and unprecedented increase in the service to rural power districts were two outstanding features of "Hydro" progress during the past year. There has, however, been a steady growth in the co-operative systems and once again the problem of future power supplies assumed prominence.

### Satisfactory Growth in Load

*Northern Ontario Properties*

Comprised in the Northern Ontario Properties are generating and transformer stations, and transmission and distribution networks scattered throughout the vast area forming the northern part of the province. These properties, under agreement, the Commission operates on behalf of the Province. Their output is chiefly used in connection with mining developments and for the municipalities associated therewith. The remarkable expansion of the mining industry in Northern Ontario during the past few years continued in 1937 and was reflected in further growth in the Commission's power load. The figures for December are not yet available but the following tabulation compares the loads for October, the last month of the Commission's fiscal year and are representative of the growth during the year.

Growth in Primary Load 1936-1937—Northern Ontario Properties

| District | Peak h.p. Oct., 1936 | Peak h.p. Oct., 1937 | Increase h.p. |
|---|---|---|---|
| Nipissing | 4,115 | 4,812 | 697 |
| Sudbury and Espanola | 14,122 | 14,611 | 489 |
| Abitibi | 76,944 | 93,834 | 16,890 |
| Patricia | 4,182 | 5,013 | 831 |
| St. Joseph | 1,702 | 2,708 | 1,006 |
| Total | 101,065 | 120,978 | 19,913 |

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JANUARY, 1938



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

*Co-Operative Systems*

A steady, though less spectacular, growth in load has also taken place in the co-operative systems, as is shown in the following table:

Additions to Generating Equipment

Additional power supplies sufficient to take care of normal growth in load of the Niagara system must come from large developments. In Southern Ontario, the undeveloped hydraulic powers of the required magnitude are on international or inter-provincial rivers. Apart from the protracted negotiations which would inevitably precede agreements permitting the start of such developments the actual construction period would be measured in years. Development or control of additional supplies of power from sources in Ontario, however, has been arranged for in several localities during the past year.

In the Georgian Bay system, the construction of a new generating station on the Musquash river, to have a capacity of 10,000 horsepower, was commenced. It is to be completed in 1938.

In the Eastern Ontario system, the Commission, in November, 1936, approved the purchase of three plants on the Otonabee river, the property of the Canada Cement Company. These plants are known as Douro at lock 24, with a capacity of 1,000 horsepower; Lakefield at lock 26, ca-

Growth in Primary Load 1936-1937—Co-Operative Systems

(Including Rural Power Districts)

| System | Peak h.p. Oct., 1936 | Peak h.p. Oct., 1937 | Increase h.p. |
|---|---|---|---|
| Niagara | 989,275 | 1,094,504 | 105,229 |
| Georgian Bay | 26,555 | 29,310 | 2,755 |
| Eastern Ontario | 111,421 | 125,395 | 13,974 |
| Thunder Bay | 83,090 | 88,800 | 5,710 |
| Manitoulin R.P.D. | 138 | 138 | ........ |
| Total | 1,210,479 | 1,338,147 | 127,668 |

pacity 2,600 horsepower, and Young's Point at lock 27, capacity 600 horsepower. The Douro plant was rehabilitated and came into service at the end of July, 1937. During the year the Commission also obtained control of two plants, formerly the property of the Quinte and Trent Valley Power Company. These small plants are known as the Sills Island generating station at Frankford, capacity 2,200 horsepower and the Campbellford generating station of 1,000 horsepower.

In Northern Ontario, a second unit of 5,000 horsepower has been installed at Ear Falls generating station on the English river. It was placed in service in June last to supply the Red Lake and Woman river districts.

To augment the power supply of the Nipissing and Sudbury districts, the Commission purchased from the Abitibi Power and Paper Company its plant at Crystal Falls on the Sturgeon river. This plant has a capacity of 10,000 horsepower.

### WATER STORAGE

Except on the Niagara river, where the natural storage of the Great Lakes maintains a remarkable uniformity of flow and diversions for power purposes are governed by treaty provisions, it is usually necessary in connection with hydro-electric power developments, to provide storage facilities to conserve the runoff in order to increase the flow during periods of low water.

During the past year, the Commission has started the construction of a storage dam to control Frederick House and Night Hawk lakes on the upper waters of the Abitibi river. This reservoir will make more dependable the power available at the Abitibi Canyon Development. Certain benefits to local navigation will also result from this improvement, and the Provincial Government is paying a proportion of its cost.

### INCREASED TRANSMISSION & DISTRIBUTION FACILITIES

During the year it has been necessary to provide increased transmission and distribution facilities in many districts.

In the Niagara system the transformer capacities of the 110,000-volt stations at Hamilton, Thorold, London and York are being increased. In the Georgian Bay system an additional section was changed over to 38,000-volt operation. This involved some new 38,000-volt line, extensive alterations in the auto-transformer station at Eugenia and the construction of a 6,000 kv-a. auto-transformer station at Fergusonvale.

In the Eastern Ontario system, about 120 miles of 110,000-volt circuit was erected between Chats Falls and a new 15,000 kv-a. transformer station at Trenton. In the Thunder Bay system a 110,000-volt circuit about 100 miles long was built from Cameron Falls to a 9,000 kv-a. transformer station under construction in the Long Lac area. A 450-kv-a. distribution station was installed in the mining town of Geraldton and a 200-kv-a. station was constructed at Beardmore.

In the Northern Ontario Properties, an additional 4,500-kv-a. transformer bank was installed at Timmins and the newly purchased Crystal

Falls plant was connected to Coniston generating station.

In all, nearly 225 miles of 110,000-volt transmission lines and 117 miles of 44,000 and less voltage lines were built. This is exclusive of the extension to primary lines in rural power districts. Ten new distribution stations were installed throughout the various systems and the capacity of nineteen others was increased.

### Capital Expenditures

The extensions to generating stations, transmission lines and distribution networks, storage works, etc., during the year have required capital expenditures of about $8,120,000 as follows:

Approximate Capital Additions Year Ended October 31, 1937

| | |
|---|---|
| Niagara system | $1,225,000 |
| Georgian Bay system | 900,000 |
| Eastern Ontario system | 2,143,000 |
| Thunder Bay system | 723,000 |
| Manitoulin & Nipissing rural power districts | 11,000 |
| Northern Ontario Properties | 1,448,000 |
| | $6,450,000 |
| Provincial Rural Grant (To Oct. 31) | 1,670,000 |
| Total | $8,120,000 |

### Capital Investment

During the year the total capital investment relating to the power undertakings of the Commission has grown from close to $306,000,000 to more than $314,000,000. Both figures include Provincial grants for rural electrical service which to the end of 1937 had amounted to approximately eleven and three-quarter million dollars.

### Reserves

During the past year the Commission's financial reserves, including those for Northern Ontario Properties, insurance, workmen's compensation, and staff pension provisions, increased from $90,285,772 to about $102,300,000—a gain of about $12,000,000. The gain in reserves of the municipal utilities cannot be given until after the close of the calendar year but it is of interest to note that during the period of depression these reserves increased from $44,058,573 at the end of 1929 to $75,187,970 in 1936, a gain of $31,129,397 or 70 percent. The gain in the Commission's reserves during the same period was from $45,881,750 in 1929 to $90,285,772 in 1936, a gain of $44,404,022 or 97 percent; notwithstanding the utilization during the depression of a substantial proportion of the contingencies reserve accumulation for the stabilization of wholesale costs of power.

### Operating Results

The summarized operating results of the co-operative systems and of the Northern Ontario Properties, for the year ended October 31, 1937, are approximately as follows:—(See statement on next page.)

### Rural Electrical Service

During the past year there took place the greatest expansion in rural electrical service on record. The total mileage of rural primary lines approved for construction was 2,300, substantially exceeding the previous high of 1,894 miles in 1930, and equalling in one year the mileage approved for construction in the five previous years 1932 to 1936. Some

### OPERATING RESULTS

| | Co-Operative Systems | Northern Ontario Properties |
|---|---|---|
| Revenue | $31,155,597 | $2,966,234 |
| Operation, maintenance, power purchased, administration and interest expenses | 22,546,565 | 1,825,538 |
| Provision for reserves | 7,318,505 | 1,229,231 |
| Total expenses and reserves | $29,865,070 | $3,054,769 |
| Net balance (approx.) | 1,290,527 | (88,535) |

13,000 new rural consumers were connected to the lines during the year. About half of these were new consumers on existing lines and half were new consumers on extensions built during the year.

Further substantial reductions were made during the fiscal year in the rates to rural consumers. On December 1, 1936, the service charge to ordinary farm classes was reduced to a maximum of $1.00 per month net, and in August, 1937, this reduction was extended to all hamlet classes, except to summer cottages using electric stoves or other large appliances requiring a three-wire service. Insufficient time has elapsed since the last reduction was put into force to determine the full effect of these reductions upon the financial operation of the rural power districts. The low rates, however, have unquestionably stimulated a demand for the construction of primary lines to many areas not hitherto able to apply for service. The increase in the number of consumers on existing lines is especially satisfactory, as when these new consumers have had time to install the necessary equipment the additional revenue derived will partially offset the reduced revenues from existing customers.

There has been some increase in the street lighting in hamlets and small villages but in this regard there is still room for much improvement.

To construct the new primary lines and to provide equipment to serve new rural customers on existing lines required a capital expenditure during the year of about $5,000,000. Approximately half of this is provided by the Provincial government as a grant-in-aid.

Efforts to inform the rural consumer respecting the advantages and economies of electrical service are continuing. In connection with the Canadian National Exhibition at Toronto, the Provincial Plowing Match at Fergus, Wellington County, and the Royal Winter Fair at Toronto, exhibits were arranged by the Commission in conjunction with various manufacturers of equipment. It is estimated that about 110,000 people attended the Plowing Match, and the Winter Fair is largely patronized by farmers who evince a keen interest in the displays.

### SUPPLEMENTARY POWER SUPPLIES

Toward the close of the year, following discussions and negotiations, new agreements were entered into with Gatineau Power Company; Maclaren-Quebec Power Company and The

Beauharnois Light, Heat and Power Company. Statements respecting these agreements have already appeared in the press. By the new agreements both the Commission and the companies benefit by the termination of the litigation which followed the cancellation of the original contracts.

With respect to any plans for industrial development, Ontario citizens may move forward with confidence, in the knowledge that both for present needs and future growth, there is assurance of ample supplies of power, at no increase over the present low costs to the consumer.

# Explosives

By Gordon Mitchell, Assistant Construction Engineer, H.E.P.C. of Ont.

THE subject is explosives, how to use them and how not to use them. I do not profess to be an expert on explosives, but by telling you what I have learned in the years that I have been in the construction game, it may not only help you with your explosive problems but make explosives safer to work with.

I will say things about explosives with which you are thoroughly familiar, but it is only by repeating and stressing the various points in the handling and use of them that any degree of safety can be attained.

I will first say a few words about explosives, detonators and accessory supplies.

Commercial explosives are solids or liquids which can be instantaneously converted by friction, heat, shock, sparks or other means into large volumes of gas. There is no magic about explosives. When fired or exploded they simply change form, largely gaseous, into many times greater volume. This increased volume exerts both a blow and pressure on the confining material. It is this action that is effective in blasts. The pressure acts equally in all directions but the gas tends to escape through the easiest way out, which is usually the drill hole. Therefore loading and tamping must be done very carefully in order to confine the gas so that it will be forced to work upon the material to be blasted.

The explosive with which you men usually deal is dynamite—a high explosive. There are several kinds of dynamite but the one that is in general use in our work is Polar Forcite Gelatin, which is usually supplied to us as 40 percent or 60 percent. Sixty percent has somewhat higher strength than 40 percent, being in the ratio of about 1¼ to 1. Polar Forcite is particularly adaptable because of the high velocity of explosion which gives a quick shattering affect and because of its plasticity, that is, it can fill a drill hole solidly without any air spaces. It is also a low freezing explosive. It is sup-

plied in cartridges usually 1⅛ in. diam. by 8 in. long.

Now high explosives are not fired by sparks or flames but by means of an intermediate agent or detonator such as blasting caps or electric blasting caps. These are charged with a powerful explosive, usually fulminate of mercury with chlorate of potash which detonates the main charge by a combination of shock and heat. Single charges are fired by means of a blasting cap and fuse or an electric blasting cap, but when several charges must be fired simultaneously the use of electric blasting caps is essential.

Blasting caps are small metal cylinders closed at one end, and loaded with a very sensitive but violent explosive, and fired by the spit or spark from safety fuse. There are two kinds generally used No. 6 and No. 8, the No. 8 being about twice as strong as No. 6.

Safety fuse consists of one or more centre threads surrounded by a train of special black powder made for fuse, this core being enclosed in various wrappings of textiles and waterproofing materials. Its purpose is to carry fire at a continuous and uniform rate to the blasting cap. The protective coverings minimize the chance of setting fire to the charge of explosive by sparks from the side of the fuse before the fire has reached the blasting cap.

There are several brands of safety fuse, some with more waterproofing and protective coats than others. You will sometimes get a black covered fuse. This is a better water-proofed fuse than the white.

When the charges in a number of drill holes are fired simultaneously, electric blasting caps must be used. These are of similar construction to the blasting caps only instead of the open end, this end is used for the entrance of lead wires to the bridge wire embedded in the explosive. Although electric blasting caps are well insulated against water, they are not intended for extreme conditions. If used in water, water may penetrate and spoil the charge. For this work waterproof electric blasting caps are supplied. Electric blasting caps are supplied in No. 6 and No. 8. No. 8 being about twice as strong as No. 6. Waterproof electric blasting caps are always No. 8. The electric blasting cap wire may be obtained in almost any lengths up to 30 ft. If it is found that electric blasting cap wires are too short to reach from hole to hole for connecting then they may be spliced with No. 20 insulated copper wire which is supplied in spools. Leading wire is used to carry the current from the blasting machine or switch to the electric blasting cap wires in the bore holes and return. It is usually a heavily insulated No. 14 copper wire.

The blasting machines or batteries used are the push down type. They are small, portable dynamos in which the armature is rotated by the downward thrust of the rack bar. Blasting machines are furnished in 4 sizes. The one which the Hydro uses will safely explode 25 to 30 detonators 10 to 12 ft. long.

There is also another essential piece of equipment when considerable blasting has to be done, and that

is a galvanometer. It is used to test individual electric blasting caps or to determine whether or not a blasting circuit is closed and in the proper condition for the blast, or whether it is open because of faulty connections or broken wires. It is a magnetic device which in use moves a pointer across a scale. The pointer is moved by a small chloride of silver cell.

This then is a brief summary of the essential materials and equipment used in blasting. They are,—

1st the explosive—the common one being polar forcite gelatin dynamite of 40 or 60 percent strength.

2nd the blasting cap No. 6 or No. 8 and safety fuse.

3rd the electric blasting caps or waterproof electric blasting caps with connecting wire, leading wire, blasting machine or battery and the galvanometer.

Now as to the uses and care of dynamite and its accessory materials and equipment. Let us suppose that a new job is starting up, whether it be a line job, a hydraulic job or an excavation for an operator's cottage and explosives have to be used for rock excavation or other purposes. An order is placed for explosives and caps. If in large quantities the order will likely be shipped freight and then transported to the job. If in small quantities an order will likely be sent to a local hardware merchant. In either case transportation by truck, car, wagon or sleigh to the job is inevitable. What are the main safety measures to be taken to ensure safe transportation? They are,—

1. Blasting caps, metal tools, hardware or any inflammable material shall not be transported in the same vehicle with dynamite. I'm afraid that this is a rule that is very often disregarded. A foreman having to send a considerable distance for dynamite and caps will have them brought back together in the same vehicle. Don't do it. Make two trips—one for the dynamite and the other for the caps.
2. When transporting explosives, it is desirable to wrap the cases in blankets, but in any case always tie the cases with ropes to fixtures in order to prevent any movement.
3. In hauling through cities or towns avoid congested areas, streets, and unnecessary stops.
4. When explosives are on vehicles without tops, they should always be protected from the sun and weather by a tarpaulin.
5. A red flag 24 in. square must be displayed by day, and a red light shown by night on any vehicle transporting explosives. This is a government regulation.

At this point let me say that explosives are dangerous when abused but are safe to handle when treated with due respect for their properties. Carelessness and rough handling are likely to cause explosions and accidents.

Now that the dynamite and caps have reached the job safely, then arises the question of storage and handling. In this connection it is well to keep in mind that the object aimed at in the use of explosives is that of complete detonation of the

material at the time and place desired, without danger to life or property. The condition of the explosives concerned has a direct and important bearing on the success of this operation and this condition depends largely on the way in which they have been handled or stored. Storage with us is understood as being in temporary magazines of our own and not in commercial magazines.

The first question to be decided is the location of the magazine. A magazine should be so situated that the accidental explosion of its contents is not likely to cause any serious damage to other buildings or injury to persons. When looking for a site, attention should be given to the possibility of finding one which will protect, by intervening high ground any buildings or roads in the vicinity. As a general rule for any quantity up to 500 lb. of dynamite or 2,000 caps, the minimum distance to be observed is 100 yds. I say 500 lb. of dynamite *or* 2,000 caps because dynamite or caps should never be stored together—a separate building or container should be supplied and these should be well separated from each other.

Now a few words as to how to store and handle dynamite.

> Storage should be in locked, dry, well ventilated buildings or containers, thoroughly weatherproof.
>
> Do *not* store any other materials in with dynamite. Stack the cases of dynamite top side up: in other words—so that the cartridges are lying flat not standing on end.
>
> Do not throw boxes of explosives violently about or slide them over each other on the floor. Treat them gently under all circumstances.
>
> At all times keep the magazine clean and free from litter, both inside and outside.
>
> Smoking while near or in a magazine and while handling explosives is absolutely prohibited. If artificial light is required in the magazine use only an electric flashlight or lantern. Do not use oil burning or chemical lamps, lanterns or candle.
>
> Do not allow shooting or the carrying of firearms near a magazine. Keep unauthorized persons away.
>
> Make only one reliable man responsible for all handling of your explosives. The normal man for this duty is the powderman.
>
> In organized territory several municipalities have special regulations governing the use and storage of explosives within their boundaries. Find out if such exist and adhere to them.
>
> All explosives deteriorate with age. Store so that older stocks may be used first.

Blasting caps and electric detonators should be stored and handled generally under the conditions described for dynamite. Bear in mind, however, that the explosive component of a cap is much more unstable and susceptible to shock than dynamite and these articles should be handled even more carefully.

On account of the danger they

present to children and unthinking persons, caps and detonators should be most carefully guarded and kept out of unauthorized hands. Just a few days ago I heard of a young fellow who had listened to older men talking about exploding dynamite under water to obtain fish. He thought he would try it and he secretly got the caps and dynamite. Instead of using safety fuse, however, about which he had not heard, he actually tried to light the cap with a match. Result: loss of four fingers and an eye.

Damp is a particular enemy of caps and safety fuse, hence the need of dry storage of these. I might say here that the proper place to store fuse is with the dynamite and not with caps. It should be kept cool and dry.

Damp or water destroys the explosive in the detonator. In fuse it attacks and renders useless the powder core at the exposed ends of the fuse.

Poor condition of dynamite and exploders usually due to age and improper handling is often the cause of misfires with all their attendant dangers, delays and expense. Too much care can hardly be taken to eliminate such possibilities and the above simple rules if followed will go far to ensure that the explosive will go to the drill hole in first class shape.

Now let us assume that the dynamite, caps, and safety fuse are safely in storage and that there are several holes ready for shooting. The technical features and methods used in drilling will not be entered into here. The powderman is told to go ahead and shoot the holes. He should have with him when he goes to the magazine to get the small quantities of dynamite and caps necessary for the shot, two small portable hand magazines, one for the dynamite and fuse, the other for the caps. Each consists of a strong wooden box provided with handle and cover, the one for the caps being lined with a heavy felt. Both magazines are painted red and are both supplied on requisition. The powderman reaches the dynamite house, unlocks the doors and takes out a case of dynamite. Do not allow him to open cases in the magazine—he should carry them at least 50 ft. away. After doing this he proceeds to open the case. A wooden wedge and mallet should be used for this. Do not allow him to use chisels, screw drivers or anything except wood, copper or brass. The reasons for this are that frequently dynamite "leaks," that is, nitroglycerine leaks from the cartridge and impregnates the wood. Now nitroglycerine is very susceptible to friction and you can easily see what may happen if iron is used. So the case is opened and a number of sticks transferred from the case to the portable magazine. Then the case is returned to the magazine and the magazine locked. Fuse is also taken if fuse is to be used. Then the powderman proceeds to the magazine containing the caps and the same procedure followed. He then proceeds to the location of the blasting operations.

His first job there is to test the depth of the hole with his tamping stick. This is a wooden stick—never use anything but wood for tamping.

He tests the depth of the hole to give him an idea as to the condition of the hole and quantity of dynamite to use. His next job is to make up a primer. A high explosive cartridge with an electric blasting cap, or blasting cap inserted is called a primer. It should be carefully made,—

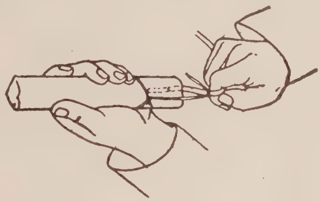
1. To insure the complete detonation of the explosive.
2. To keep detonator from pulling out of the explosive.

Suppose the primer is being made up with blasting cap and safety fuse. In all cases of blasting the length of fuse must be governed by

*Tie cord around cartridge.*

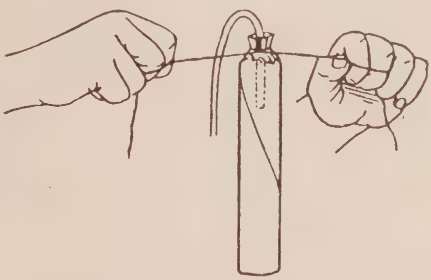
the time required for the blaster to reach a safe place after lighting the fuse or fuses. In any case never use less than 3 ft. The rate of fuse burning is usually at the rate of one foot in 30 to 40 seconds, but a good powderman will always cut a 3 ft. length and find the time of burning himself. In case a little dampness has affected the end of the fuse, it is advisable to cut an inch or so off the end first, and make sure a square cut is made. Then the blasting cap is slid over the end of the fuse so that the fuse reaches down to the explosive charge in the blasting cap. When this has been done the cap is securely fastened in place by crimping, which is done close to the open end of the cap. If the cap is to be used under water the union between blasting cap and fuse should be protected against moisture. Canadian Industries have a special cap sealer but whatever is used, use nothing that contains oil, as it will injure the fuse. There are three usual means of inserting the cap in the cartridge of dynamite.

*First*—With a wooden awl, punch a hole straight into the end of the cartridge of sufficient depth to receive the cap, then insert the cap with fuse attached and fasten it there by means of cord tied first around the cartridge and then around the fuse.



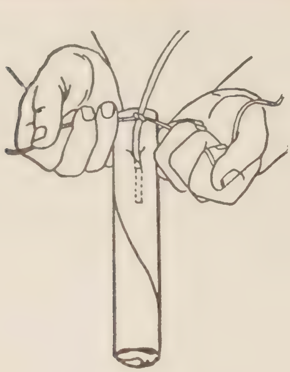
*Then around fuse.*

*Second*—Unfold the paper from the end of the cartridge, punch a hole directly into the centre of the exposed dynamite, insert the cap with fuse attached, close the loose part of the paper around the fuse and tie tightly.

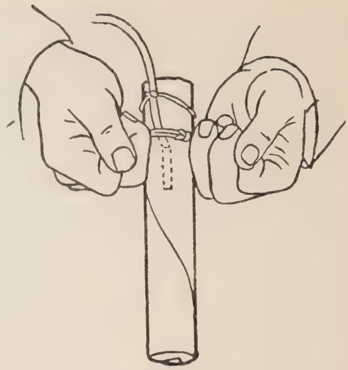


*Tying paper shell around fuse.*

*Third*—Punch a hole into the side of the cartridge starting the hole



*Tie cord around fuse.*

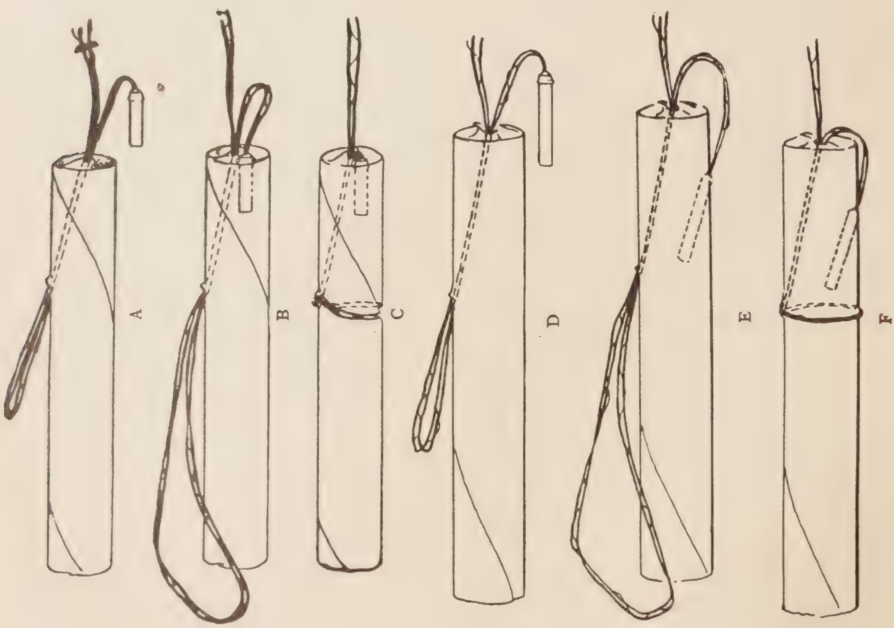


*Complete by tying around cartridge.*

about 1 or 1½ in. from one end and pointing in and toward the other end. Insert the blasting cap with fuse attached and securely fasten by means of a cord tied firmly around the fuse and then around the cartridge.

The method of priming in the side has the advantage of leaving more space for placing the tamping stick on the primer without bending the fuse, but primers so made cannot be used in such small holes because of the increased diameter.

Now suppose the primer is being made up with electric blasting caps. First test the cap with a galvanometer, if one is used. Then any one of these methods as outlined for blasting caps can be used, but the method preferred is as follows.




*Correct method of priming with electric blasting caps.*

Punch a hole in the centre of the end of the cartridge in a slanting direction so that it will come out at the side 2 or 3 in. from the end, insert the end of the doubled over wires of the electric blasting cap and loop these around the other end of the cartridge. Punch another hole in the top a little to one side of the first and straight down or in the side starting the hole about 1 inch from the end and pointing in and towards the other end and insert the cap in this last hole. Pull up the slack of the wires. You now have a primer in which the wires do not cross each other at any point, and the primer will hang vertically.

Many powdermen make a half hitch of the wires around the cartridge. This is wrong because a strong pull is likely either to break the wires or to cut the insulation.

Now the powderman has the primers ready. He should never make up more than the number he is going to use at the time.

The next procedure is the charging of the hole.

When blasting rock the powderman must use his own judgment as to the amount of dynamite used. The method of procedure depends upon whether the rock is hard or soft, and if in layers whether the seams are horizontal or vertical, and a number of other circumstances. If one or more cartridges or sticks are used, it is best to slit the paper shells lengthwise on one or two sides with a case knife doing this to all of the cartridges except the primer which contains the cap. When the slit cartridges are placed in the drill hole, it will be found that they spread out better than if the paper was not slit, but do not slit cartridges for wet holes.

Push the cartridges, except the primer cartridge, firmly down in the hole with the wooden tamping stick, so as to cause them to expand and completely fill the hole. Crevices or air spaces greatly lessen the power of the explosion. Each successive cartridge must touch the one previously loaded because if any spaces between cartridges occur through falling dirt or stone, a part of the charge may fail to explode.

When all of the cartridges which it is intended to use, except the primer cartridge, have been put in place, load the primer cartridge taking care that the closed end of the cap is directed toward the charge. The primer is pushed down only hard enough to touch the last unprimed cartridge. If the primer cartridge is the only one required in the charge, lower it carefully into the drill hole, being careful not to apply any strong pressure in getting it into place. When applying pressure on the primer it is essential that the cap is not moved, and that the electric wire or the safety fuse be not damaged.

After the charge of dynamite, including the primer, is in the hole, 2 or 3 inches of fine dirt or sand is placed in the hole and pressed gently into place on top of the dynamite with the wooden tamping stick. The operation is repeated until the hole is filled. After 6 or 8 inches of tightly tamped material covers the charge, the pressure applied in tamping may be increased. Never use a

metal bar for tamping, and also always keep a slight tension on the safety fuse or wires so that they will not become kinked. This operation is repeated for every hole to be loaded.

Springing of holes will be discussed a little later on.

Now the powderman has all the holes loaded. If there are few holes and he has used blasting caps and safety fuse no other preparation is necessary before firing the charge except to remove the magazine containing the remaining dynamite and caps to a safe distance and to give proper warning to all persons who may be in the neighbourhood of the work to stand clear at a safe distance. This is usually done by a shout, to warn all persons that a blast is about to go. Guards are also placed at suitable spots. What constitutes a safe distance must be governed by the individual blast. When he is satisfied that everyone is at a safe distance and after guards are placed, he will then give a final shout of warning and proceed to light the fuses. This should be done in a quick but orderly manner. It can be hastened by slitting the ends of the fuse to expose the powder train for easy ignition. The blaster should immediately retire to a safe distance.

If electric blasting caps are used and there is more than one hole, then connect all wires in series. For a great number of holes, wires may be connected in parallel or in other combinations. These should not be blasted with a blasting machine, and will not be discussed here. For ordinary blasting of not more than 30 holes, always connect in series when using the push down type of blasting machine. Connections must be carefully made, twisting the wires with a long twist. Never make connections by a loop. To guard against short circuits, it is always advisable to raise the connections off the ground by supporting the insulated part of the wire by stones or sticks.

The powderman is now nearly ready to fire, and he makes a test of the circuit with the galvanometer. As in the case when safety fuse is used magazines are moved to safe distances and people warned. Guards are also placed. Before connecting the leading wires, however, he usually leaves his helper at the spot and personally goes to see that the leading wires are not connected to the blasting machine or battery. In fact a careful powderman never loses sight of battery. He has it with him when loading the holes. However, when he is satisfied that everything is correct he connects his leading wires. Then he goes to the end of the leading wire, which is in a safe place or at a safe distance, and after giving a last shout of warning and satisfying himself that all persons are at a safe distance, he connects the lead wires to the binding posts of the blasting machine and immediately operates the machine. After the blasting he should immediately disconnect the lead wires from the machine.

In case of a failure of the blast to go when using electric caps, the blaster is safe in disconnecting his wires and returning immediately to look for trouble.

When using fuse and blasting caps, it is not safe to return to look for the cause of a failure, until a considerable time has elapsed.

After the blast is fired the blaster should wait a sufficient length of time to allow the falling matter to drop, and for the smoke, fumes and dust to be partially dissipated or blown away.

### MISFIRES

Misfires are usually the result of carelessness. Misfires with electric blasting caps are usually the result of broken wires, faulty connections, or short circuits. The galvanometer is a useful piece of equipment in finding where the trouble lies.

When caps and fuse are used great care must be exercised. It is never safe to go back to the scene of blasting immediately until all shots have been counted.

A good powderman when he returns will always examine for missed holes. Quite often he will see a pair of wires coming out of a tamped undisturbed hole, apparently unexploded. He immediately tries it with his galvanometer, and if a movement of the dial is shown, he will immediately prepare to blast that hole in the ordinary way with all precaution.

It is not safe to remove the tamping of a charge of dynamite that has failed to explode in order to put another primer on top of the charge. The safest procedure is to drill another hole about 2 feet away, which shall be then charged and exploded. Careful search of the debris should be made to discover and remove any particles of explosives which have failed to be discharged.

In the hands of a careful man, tamping may be blown out with air or washed out with water, but there are provincial laws forbidding this.

Now about springing holes. Drill holes are frequently sprung or chambered with dynamite. This makes it possible to keep the charge well down in the bottom of the drill hole, where it is generally most needed, and also place the required amount in the hole.

A hole is sprung or chambered by exploding in the bottom several charges of dynamite one after the other. The first charge usually consists of one or two cartridges, this being increased in subsequent charges until the chamber is sufficiently large to hold the requisite quantity of explosives. The explosion of each chambering charge increases the bore hole slightly in depth, and in diameter at the bottom. After a little experience the approximate size of the cavity can be estimated by noting the increase in depth with the tamping stick. A little tamping of the springing charges will give better results.

It is absolutely necessary, in order to avoid accident, that ample time be given the drill hole to cool off after each springing shot and before charging it again. Just how much time should be allowed depends on a number of conditions, but in no case should it be sooner than a couple of hours after the explosion of the last springing charge, and it is better to wait 4 or 5 hours, unless water has been used to cool the hole. The blaster should stand as far back from the mouth of the drill hole as possible when loading any subsequent charges.

Canadian Industries Handbook on blasting states that "when a bore hole is tested with a thermometer after springing we recommend that no explosive be introduced unless a reading of less than 80 deg. fahr. is obtained".

I can only remind you of the last dynamite accident to warn you of the danger of introducing explosives to a hot hole.

Just a few words now about disposal of dynamite and caps after the job has been completed and being cleaned up. Usually unbroken cases can be sold back to the dealer, but as a rule he will not accept broken cases. What would you do with these few sticks of dynamite and some caps? *Do not bury them.* On one of our jobs a few years ago caps were disposed of by burying in a box. Some 6 years later they were uncovered by some boys and the result was an accident.

The best way to get rid of caps is to explode them.

The best way to get rid of dynamite is to burn it. This also applies to old dynamite which has become soft and mushy, and which is very dangerous in this condition.

When dynamite is to be burned, take it to a safe distance from houses and roads, open the cases very carefully, take the cartridges out, slit them and spread them over the ground instead of piling them up. If the dynamite appears too wet to burn readily a little kerosene may be poured on it. A small pile of paper, shavings, or other combustible material should be placed close enough to the dynamite so that the flames will burn along the paper or combustible material and ignite the dynamite. After lighting return to a safe distance until all the dynamite is burned. The wooden cases should be piled separately and burned. Do not burn more than 100 lbs. of dynamite at a time, and for each burning a new space should be selected.

In a report on "Explosive Accident" issued by the Explosive Division of the Mines Department, Ottawa, covering a period of seven years, it was reported that 756 accidents occurred, causing over 200 deaths and 500 injuries. The accidents are reported under the following headings, the percentage of the total being given in each case.

| | | |
|---|---|---|
| 1. | Not taking proper cover, or being hit by flying debris | 25.4% |
| 2. | Playing with detonators | 18.5% |
| 3. | Premature blasts | 11.5% |
| 4. | Playing with explosives | 10.6% |
| 5. | Hang fires (this applies specially to use of safety fuse) | 8.7% |
| 6. | Boring into unexploded charges | 6.8% |
| 7. | Striking explosives in Blasted Material | 5.7% |
| 8. | Preparing charges | 5.3% |
| 9. | Tamping charges | 3 5% |
| 10. | Tampering with misfires | 1.8% |
| 11. | Sparks and flames | 1.2% |

I will repeat what I already have told you. Explosives are dangerous when abused, but are safe to handle when treated with due respect for their properties.

# The Sun Circle

By F. K. Dalton, H.E.P.C. Laboratories

EVER since the earliest days when man realized that day and night were marked off by the sun, and with evident regularity, he has endeavoured to measure certain features of the sun's apparent motions in the sky, and one of these features has been that abstract, though very real quantity,—Time.

The first devices used were, of course, exceedingly crude but by carefully watching the shadows from day to day the observers were able to obtain considerable valuable information,—the variations in the altitude of the sun and length of the day, the rates of these changes, and the length of a complete cycle of these variations,—the year. The day was then divided into many parts which now have become our hours, minutes and seconds.

One of the most popular of the early devices was the sundial, consisting of a flat horizontal plate with clocklike graduations and a vertical part, known as the gnomon, the front edge of which cast a shadow line that indicated the hour. Sundials may appear in various forms but these are the essential features.

At the present time many sundials, Fig. 1, are used as decorations in garden designs, and their presence adds considerable interest to the arrangement. As time-measuring instruments, however, they are of little value for the corrections to be taken

*Fig. 1.—A garden sundial for Latitude 44° North, suitable for use in Toronto.*

into account may be quite large, i.e., as much as 45 to 47 minutes in the months of February and November.

Realizing the errors inherent in the sundial, the writer suggests, for a garden clock, a unique and quite simple device, the "Sun Circle," which may be adjusted to correct for four conditions and then clamped. It can be set to indicate Local Solar Time, Eastern Standard Time, or Eastern Daylight-Saving Time. When properly adjusted, it may be read easily, even by a child, within an accuracy of half a minute.

The Sun Circle, shown in Figs. 2 and 3, consists primarily of a brass circle, or rather two-thirds of a circle, graduated uniformly in hours, half and quarter hours, with a gnomon of phosphor bronze wire which casts a slowly moving straight-line shadow on the inside of this brass circle. The position of this shadow indicates the time.

*Fig. 2.—The Sun Circle, north side, showing sector and scale for longitude, solar variation and daylight-saving adjustments.*

*Fig. 3.—The Sun Circle, south side, showing graduations and the latitude adjustment.*

The circle can rotate about the base of the gnomon and is clamped through a sector, which is attached to the circle and graduated, also uniformly, on a two-hour scale.

The instrument is mounted so that the top edge of the circle is in a plane parallel to that of the earth's equator, and with the gnomon parallel to the earth's axis, and therefore pointing directly at the north celestial pole.

Adjustment for the latitude of the location, within a range of a few degrees, is made by means of locknuts at the base of the gnomon. When thus adjusted, and clamped with the 12 o'clock graduation opposite the zero mark, the Sun Circle reads Local Solar Time, as a sundial, and is subject to all of the errors and corrections of the same.

The longitude of Toronto is 79° - 24′, West of Greenwich, or 4° - 24′ West of the Eastern Standard Time (75th) meridian. Therefore, the sun each day crosses the Toronto meridian 17 minutes, 36 seconds after it has crossed the "standard" meridian. This delay, which is practically constant for any given location, must be taken into account in reading time by the sun. On the Sun Circle, adjustment for the longitude of Toronto is made by rotating the circle, counter-clockwise, through the small angle corresponding to this lapse of time, as read on the scale on the sector. With this adjustment, the Sun Circle, mounted at Toronto, indicates the same as a normal sundial placed on the 75th meridian. The maximum errors then would be about 14 minutes slow in February and 17 minutes fast in November.

For locations east of the standard meridian, but still within the same time zone, adjustment for longitude would be made by rotating the circle in the opposite direction,—i.e. clockwise. To allow this adjustment, the sector must be shifted one hour along the circle. The extra hole, below the 11:30 a.m. graduation, is provided for use when the sector is thus shifted for the eastern locations.

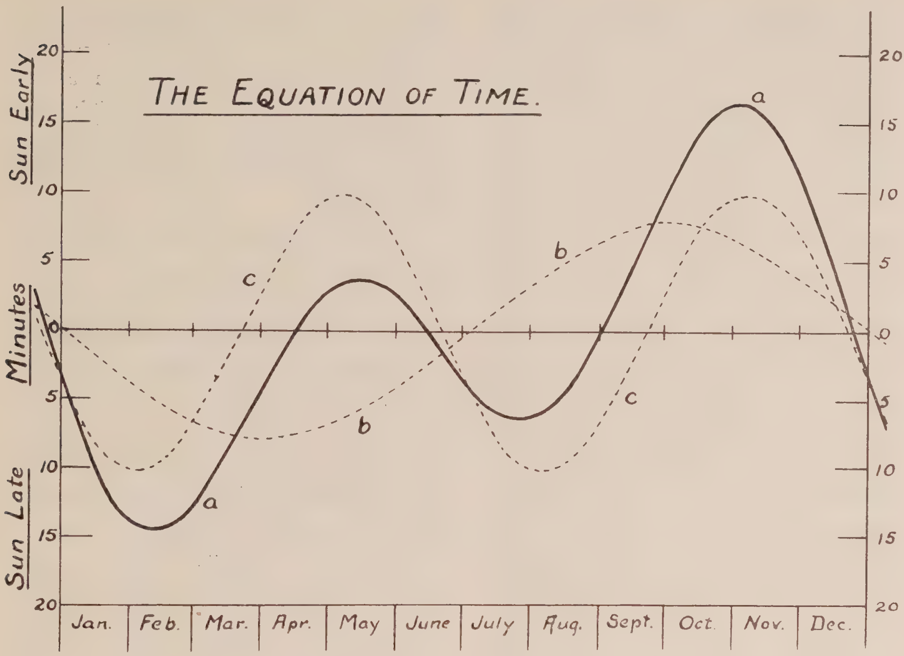



*Fig. 4.—The solar variations from the noon average,—i.e., The Equation of Time. Curve (a) shows by how many minutes the Sun is early or late in crossing the standard time meridians. This curve is the resultant of two components,—(b) variations due to the earth's orbit being an ellipse instead of a circle, and (c) variations due to the earth's axis being inclined rather than perpendicular to the plane of the orbit.*

The third adjustment is for the solar variations, known as the "Equation of Time," Fig. 4, the sun sometimes being ahead of its noon average, and at other times late, in crossing the 75th meridian. These differences are added to, or deducted from, the "longitude constant" and the circle is set and clamped. The Sun Circle then will indicate Eastern Standard Time. Adjustment for solar variations should be made daily, or weekly, throughout the year, according as the curve, Fig. 4, shows the changes to be respectively rapid or slow. With proper adjustment, the accuracy will be within half a minute,—as close as one can judge the shadow position.

Now, by rotating the circle, counter-clockwise, an additional hour, the Sun Circle indicates Eastern Daylight-Saving Time with equal accuracy.

The shadow of the gnomon is nearly four minutes wide, the centre line of the shadow being the real indicator. As the day progresses, the shadow moves clockwise, crossing each hour line in sequence, and disappears only when the sun is beclouded or otherwise shaded, and, of course, between sunset and sunrise.

During spring and summer, March 21st to September 22nd, the sun is north of the equator so it shines in over the top edge of the circle. Near the latter date, the sun crosses to the south of the equator for fall and winter but throughout this period, it rises and sets between 6 a.m. and 6 p.m. Those sections of the circle which cover 4 to 6 a.m. and 6 to 8 p.m. would now cast shadows and prevent the true shadow of the gnomon on the circle. These sections, therefore, are arranged on hinges so that they may be turned back out of the way, Fig. 3, for the fall and winter months. Also the base of the gnomon is depressed so that the framework will not cause confusing shadows during the winter.

There is one additional adjustment which may yet be found worthwhile to incorporate in this device,—namely, to correct for refraction of the sun's rays at low altitudes. This can be done by slight offsetting of the gnomon in a direction away from the zero mark.

This Sun Circle has proven of considerable interest to many visitors during the past summer while it was mounted and reading daylight-saving time from the sun. Some appreciated the technical features while others even were surprised to find that the sun was a basis for measurement of time. Possibly this instrument should bear a motto suggesting pleasant thoughts,—"I measure only the sunny hours," or, perhaps, it should be more of a reminder,—"To-day is yours,—but you have no claim on to-morrow."

# Light in the Schoolroom

By Edward Jackson, M.D.

THE command "Let there be light" was the beginning of creation, and all created life has found it "was good." Plants and animals transform the force of the sun's rays into food and life. The human race, in all languages, has used light to interpret joy, hope, intelligence, information, truth. The contrast of light and darkness explains the contrast of good and evil.

Each day in the past winter I have watched the children running to school, shouting to one another, happy to greet one another, to get together for a few minutes outdoors on the playground. It seemed so different from Shakespeare's picture of "the schoolboy with shining morning face, creeping like a snail, unwillingly to school." There seemed no reason for this contrast except that the playground was out in the sunlight and the schoolroom was in comparative darkness. Perhaps the schoolrooms were even worse in Shakespeare's time than they are to-day.

The bright joy of childhood comes to the child in the sunlight. There is no reason why he should be deprived

Read in the Symposium on Health Problems in Education, under the sponsorship of the National Education Association and the American Medical Association, Atlantic City, N.J., June 8th, 1937. Reprinted from the Journal of the American Medical Association.

of it. Long ago the fear of enemies drove cave dwellers into darkness or into forts for protection, or people have been driven into houses for rest. These have made the darkness of the shut-in and have made us tolerant of poor lighting. Our churches for introspection and colleges for instruction have given to near-darkness a prestige and toleration that make them suggestive of learning. But the child has lived outdoors in all ages, drawing health, strength, stimulus and joy from the sunshine. It is a serious change from the free, self-direction of childhood—the following of race instincts and the outlet in games that have been played for generations until they fit in with the natural development—to the performance of imposed tasks, justified only by the preparation to meet the needs of later life. This change is made more difficult by the requirement of giving up, with freedom of conduct, the stimulus of good light.

If school could begin with two years of supervised play, in outdoor playgrounds, with full light, it would help to get the full co-operation of the child. Loss of the child's hearty, interested co-operation is the first grave error of our educational system. It is a more serious error than we have known. It has set up an opposition between natural desire and suggested tasks, between normal activity and purposeful occupation, between what we want to do and what is expected of us. It sets up a conflict between study and health. Those who most need health sacrifice it for study. Those who most need opportunities of study throw them away to cultivate the natural desire for health and bodily vigor. Failure to recognize the child's inherited need and enjoyment of light outweighs in effect much of our labor on the curriculum and skill in pedagogy.

More than all else, it lowers the child's standards of health as a main objective. This is a loss which even a lifetime study of health and the health interests of patients fails to restore wholly. Let us understand this in preparing to deal with all the health problems in the schools. We, who have to consider the problems of vision in the schools, are constantly being reminded, and are often baffled, by the low standards of lighting needs that are prevalent in the community.

The light standards of the children are the light standards of the human race, the light standards of savage men who hunted and fought and worked under the open sky. They are the light standards of the higher animals that see their food and their enemies by the light of day; not that of the owl, the hyena or even the wolf, guided by the sense of smell and mainly hunting at night. The child's standards must also include those of macular vision; to recognize the minute differences in the forms of letters, textures and structures, which require more light than the objects perceived in the peripheral field of vision. The only standards acceptable for the school are those of optimal vision—the highest visual acuity, the easiest and quickest vision, good light on a cloudy day and in the morning and evening.

If we wish to inculcate principles of justice, we must practice equal jus-

tice in the essentials of school life. A physician who became the health officer of his city and the president of his state medical society knew, as a boy, that he was near-sighted. But his father did not "believe" that boys should wear glasses, and his teacher's ideas of justice did not include peculiarities or disabilities of particular boys. His teacher wrote something on the blackboard and told William to read it from his seat. William said "I cannot see it." "Yes, you can," said the teacher, and told the next boy to read it, who read it promptly and easily. "Now you can see it," said the teacher. "I can't see it," repeated William. Then, as William told it when he was president of the medical society, "he boxed my ears and gave me ten demerits."

With the light meters of the present day, the light that falls on each desk and book can be measured in every part of the schoolroom. Doing this in some of the best lighted schoolrooms of Denver, we found that the light at the bottom of the windows opening to the clear sky was from 100 to 200 foot-candles. On the tops of the row of desks nearest these windows it was from 40 to 50 foot-candles. On the desks farthest from the windows it was from 5 to 10 foot-candles, and on the blackboard smeared with chalk, on which were written things for all the children to read, it was always less than 10 foot-candles; in some parts of the room, the eyes had also to contend with glare of the reflections of the windows.

In the School Clinic of the University of Colorado Medical School, we found two sisters who had reached the seventh and eighth grades in school and who kept up with their classes. This doubtless depended on their using very strong light and getting much help from other members of their family, for they each had 15 diopters of hyperopia—more than is commonly left after removing a cataract from an eye that has previously been hyperopic.

Justice requires something more than good light in the schoolroom. But it cannot be done without adequate light for all the children. And this cannot be attained until teachers and parents and pupils understand what is good light and its great importance at all times. When all of these have mastered this essential, school authorities, school architects and school financiers still have to be educated to know that good lighting and justice are worth having in any community.—*Edison Electric Institute Bulletin.*

# An Old Provincial Highway Act

AN interesting contrast between old and new traffic regulations is seen in an extract from an old Act passed in the province of Prince Edward Island in the year 1781. Through the courtesy of E. L. Miles, of the Standard Paving Co. Ltd., Charlottetown, P.E.I., *The Canadian Engineer* reproduces this old Act as below:

"Anno Vicessimo Primo Regis Georgii III.

"At the General Assembly of His Majesty's Island of St. John, begun and holden at Charlottetown, on the Eight Day of October, Anno Domini, One Thousand Seven Hundred and Seventy-nine, and in the nineteenth Year of the Reign of our Sovereign Lord George the Third of Great Britain, France and Ireland, King, Defender of the Faith, &c. and thence continued by Prorogation until the Thirteenth Day of February, One Thousand Seven hundred and Eighty-one, and in the Twenty-first Year of His said Majesty's Reign; being the Fourth Session of the third General Assembly, convened in the said Island.

"An Act to prevent disorderly riding of Horses, and driving of Carts, Trucks, and Sleds, or any other Carriage whatsoever, within Charlottetown.

"IN Order to prevent the Inconveniences and Misfortunes which may arise from the Disorder of riding of Horses and Negligently driving of Carts, or other Carriages of Burthen of any Kind whatsoever within Charlottetown.

"I. Be it therefore enacted by the Governor, Council and Assembly, That from and after the Publication hereof, no Person or Persons whatsoever shall, on any Pretence whatsoever, gallop on Horseback, or having the Charge of driving any Horse or Horses whatsoever, in any Cart, or other Carriage of Burthen of any Kind, shall ride upon such Horse or Horses, or remain placed in or upon any Part of such Cart or other Carriage within any of the Streets or High-Ways of the said Town. And no such Driver or Drivers shall omit, during such Time to lead the Shaft or Thill-Horse by a Halter not exceeding four Feet in Length; nor shall he or they drive any such Horse or Horses faster than a Foot-pace, upon Pain of forfeiting Ten Shillings for every such Offence; the same to be paid upon Conviction by the Testimony of One credible Witness, before any One of his Majesty's Justices of the Peace, within Twenty-four Hours after such Offence shall have been committed. And in Case any such Offenders shall thereupon refuse to pay the same; then the said Offender shall be put to Labour for the space of Four Days in repairing the Streets of the said Town, or the High-Ways adjoining thereto, under the Direction of any One of the Overseers of the District of Charlotte Township. And in case of Refusal or Neglect to perform such Service, it shall and may be lawful for any Justice of the Peace, upon Complaint of the Overseer or Overseers aforesaid, to cause such Offender to be committed to Prison for the Space of Six Days, there to remain at his or her own proper Costs and Charges.

"II. And be it further enacted, That all Parents are hereby made liable for the Offences of their Children, under the Age of fourteen Years not being Servants.

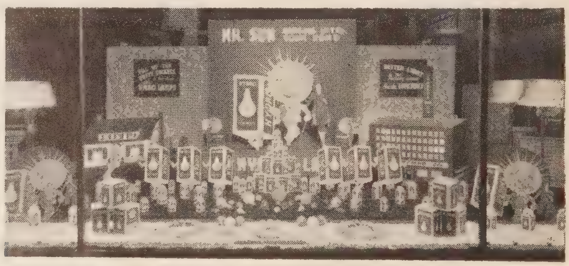
"III. And it is hereby further enacted, That all Fines and Penalties incurred by this Act, shall be paid into Hands of the Overseers of the High-Ways within the said District, to be by them applied towards repairing the said Streets or High-Ways."

# Hydro Lamp Window Dressing Contest Awards

THE 1937 Annual Hydro Lamp Window Dressing Contest was the most successful conducted to date, both as to the number of contestants and as to the ability shown in creating lamp selling windows.

This contest has become somewhat of an institution and is looked forward to by the selling members of Hydro Shops as a means of placing their best lamp window creations in competition with other Hydro Shops and it goes without saying that there is a gratifying increase in the sale of merchandise. This year the Hydro Shops were classified into four groups and this change in classification produced a greater number of entries from the smaller towns.

Class 1 winning windows are reproduced herewith.

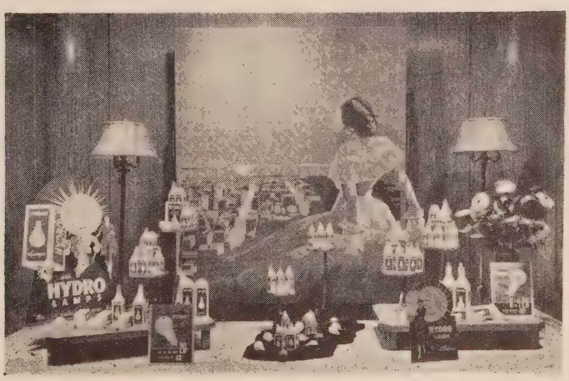


*First Prize, Class 1, The Public Utilities Commission, London.*


*Tie Second Prize, Class 1, The Windsor Utilities Commission, Hydro Division, No. 1 Store.*


*Tie Second Prize, Class 1, Hamilton Hydro-Electric System.*


*Tie Third Prize, Class 1, The Windsor Utilities Commission, Hydro Division, No. 2 Store.*




*Tie Third Prize, Class 1, Toronto Hydro-Electric System.*

# The Commission and the Employee Representation Plan

By Dr. Thomas H. Hogg, Chairman, H.E.P.C. of Ont.

*(An Address Given at a Banquet of the Niagara District Mutual Aid Society on January 12th at St. Catharines)*

THIS is the first official occasion on which I have had the opportunity of addressing a large gathering of permanent members of the Commission's staff, either in my new capacity as Chairman of the Commission or in any other. It promises to be a very pleasant experience, especially as my colleagues of the new Commission share it with me. While the Honourable Mr. Houck is well known to most of you and well liked by those who know him, you have not had the same opportunity to meet Mr. Smith. Tonight you will all have the opportunity of seeing and hearing both of these Commissioners while they deliver their messages to you.

I am informed that this dinner is given under the auspices of the Niagara District Mutual Aid Society and that the slogan of that Society is not unlike the Hydro slogan, in the one case "Power at Cost" and in the other "Insurance at Cost". The aim of your Society is a very worthy one; those of you who handle the funds and dispense the benefits know better than I how much needed and how welcome is the help which it provides in time of sickness and distress. No doubt you derive a good deal of satisfaction in return for your efforts to distribute benefits justly and in keeping with your constitution and to hold down operating expenses. Mr. Duncan informs me that expenses for last year were practically negligible—only $3.78.

As my view of the Commission's organization broadens, I have become more and more convinced of the importance of occasional functions which provide an opportunity for the staff to meet the senior officers of the organization and the Commission, and to receive official messages from management in a more direct and personal way than is possible by any method of publication. Gatherings such as you have sponsored here furnish the needed opportunity in a very pleasant and effective way.

### The Power Situation and Its Effect Upon the Permanent Niagara District Staff

Tonight I would like to devote the greater part of my time to a discussion of the Employee Representation Plan. However, before entering upon this interesting field, brief reference to an aspect of the power situation which may be of special interest to Niagara District employees, should be made. I do not propose to discuss the complex circumstances which recently led to the remaking of power contracts with the Quebec Power Companies, but rather to touch upon the question of power development at Niagara Falls.

Unfortunately the plain fact is that the international agreements which are essential to further development at Niagara Falls appear to be no nearer consummation now than they were before the first Quebec Power Contract was made. Many complex questions are involved, among them certain political issues in the United States. While we look forward with hope, the fact must be faced that the prospects are so uncertain that no reliance can be placed upon Niagara Falls as a source of additional power until they have improved materially.

The enforced deferment of power development at Niagara Falls, to which many of you may have looked forward with interest not unmixed with expectation, and the remaking of the power contracts with the Quebec power companies may, perhaps, have given rise to some speculation as to the incidental effect of these things upon the security of the positions which some of you hold. On this I can speak with assurance and I am pleased to say that the revised contracts will have no effect whatever. There is no reason to look for any reduction in permanent staff at Niagara Falls.

### Outline of Remarks on the Plan

In a recent speech, which is being published in *The Bulletin,* I expressed my general views as to the importance of direct employee-management co-operation. I am firmly convinced that there are great possibilities for mutual good in close and cordial employee-management co-operation along the lines laid down in our Plan. While excellent progress has already been made, there have been difficulties to overcome and there have been shortcomings on both sides. It is significant, however, that most of the difficulties and shortcomings may be attributed to inexperience and failure at first to fully understand or to fully appreciate the basic elements in the problem of employee-management relationship and the technique of negotiation. Therefore, it seems to me that the objects which we both wish to attain under the Plan can best be advanced by discussing the practical application of the Plan itself. Let us examine the procedure which is appropriate under the Plan, the need for responsible representation, the importance of the collective rather than the individual viewpoint, any failures on the part of either the management or the employee representatives to function as efficiently as might be expected, the inevitability of a certain amount of dissatisfaction and criticism, and, finally, the benefits which have accrued or may be expected to accrue.

### Submission of Requests and Appeals

Employees who wish to bring before management any suggestions, complaints, requests, or appeals under the Employee Representation Plan, may do so in one of two ways:

1st—Directly to management.

2nd—Through their employee representative and the machinery of the Plan.

It is recognized as a sound principle that all manner of business should be disposed of at the lowest organization level practicable. In general, individuals at these levels are

more intimately familiar with the details of the problems that arise; the business can be despatched with less explanation, less waste of time and a better valuation of the numerous factors involved. This makes for efficiency. The time of the more responsible officials thus saved may be devoted to more important and more perplexing issues and there should be less congestion of business and delays in settlement. When the lower levels fail to reach what appears to be a reasonable conclusion, recourse may be made to successively higher levels.

It is appropriate and courteous for any employee to take his problems to his immediate superior first, even though the employee may think he knows that his superior is disinclined or unable to do anything about the matter. While there would be no impropriety in shortcutting a subforeman on the ground that the foreman is really the man in charge, there would be impropriety in ignoring the foreman and appealing directly to the superintendent without the foreman's knowledge. The same principle holds true at higher levels.

If the employee is dissatisfied with the outcome of an appeal to his immediate superior, and if he wishes to carry the matter further, he may plead his own case or enlist the aid of his employee representative.

In case the employee chooses to handle his own case, it is a rather good plan to inform his immediate superior of his intention to do so and ask him for advice as to the next official who should be consulted. The immediate superior may advise the employee against pressing his case if he thinks sufficient grounds are lacking, but he has no right or power to prevent the employee from making his appeal. If an appointment is made through the immediate superior, the official to be consulted can assemble some of the needed information before the interview takes place, which may save considerable time.

In case the employee decides to enlist the aid of his representative and the machinery provided by the Plan, the representative should bear in mind the principle of "lowest organization level" and should use discretion as to what management official he consults. The appropriate official will naturally depend upon circumstances, but after a little experience and inquiry there should be no difficulty in determining whom to approach or how far up the management ladder to pursue the matter by successive appeals.

When the representative considers that his direct appeal to management officials is destined to failure, he may lay the matter before the District Committee of Employee Representatives and so the case may find its way to District Joint Conference, General Committee of Employees, General Joint Conference and finally, in very exceptional cases, to the Commission.

In the past there have been a number of occasions on which employees and their representatives have appealed directly to the Chairman of the Commission. While I freely acknowledge the right of appeal to the Commission itself, it must be made in conformity with recognized procedure. In my opinion, the case would have to be very unusual indeed to justify

an appeal to the Commission without first having been submitted in General Joint Conference. Incidentally, the Plan itself makes no provision whatever for an employee representative to consult the Chairman or the Commission on his own initiative. The only course open to employee representatives is the one specified under the Plan; and this is as it should be, for it would be illogical if not fantastic to permit one representative, entirely on his own initiative, to take the time of the Commission in the presentation of a case to which the remaining members of the General Committee of Employee Representatives might be strongly opposed. Moreover, it would be an unwarranted reflection upon the other members of that committee.

### Proper and Improper Methods

No doubt both parties to the Plan are prepared to acknowledge errors committed through inexperience. Little or nothing would be gained by examining them now but it might be well for me to stress the importance of both parties adopting an attitude which in the long run may be relied upon to give the best results. I refer to the obvious advantages of sincere straightforward dealing which engenders a feeling of mutual confidence and trust. There are times when very little is needed to damage mutual confidence and when it is well to guard against the adoption of a bargaining basis under which much more is asked than there is any prospect of gaining on the merits of the case. Give and take is necessary, but it is not necessary to put forward as fair, something that is known to be one-sided. To do so promotes uncertainty and distrust, destroys confidence and renders negotiation difficult, thereby reducing the prospect of mutual benefit.

### Authority and Control

You have pointed to widely varying standards and practices in different departments, even in different sections of the same department, and to widely different views on the part of foremen, supervisors and superintendents. You have also contended that you should not be obliged to submit to the arbitrary decision of a single official without the right of appeal and have pointed to the need for orderly standards for wages and working conditions. The management has acknowledged the justice of your claims and has established more uniform conditions of employment and recognized channels for appeals. But you must remember that the machinery which has been set up for these purposes cannot function unless you, the employees at large, accept certain responsibilities collectively.

No doubt a perfect organization would function with complete unity of understanding and purpose and without loss of effort through differences of opinion and viewpoint but, unfortunately, there are no perfect organizations.

In any undertaking involving the collective effort of a large number of persons, numerous differences of opinion are inevitable, moreover, self interest often interposes widely divergent viewpoints and aims. Much can be accomplished in the direction of unification of effort and action by intelligent explanation, reasonable-

ness and persuasion, in a word by leadership, but leadership implies authority and authority there must be. The derivation of the authority does not matter. It may arise spontaneously with common consent confirmed by precedent; it may have a democratic constitutional basis or it may rest upon despotic force. Without authority, collective effort cannot be long sustained nor can it ever be efficient.

You would not be satisfied to have a minority management group obstinately adhere to practices contrary to joint agreements. You expect management to see to it that they do not. Very well then, minority employee groups must not be permitted by you to hold out unreasonably against the application of a principle or practice agreed upon by the official representatives of all the employees. Remember I have not said that this has happened, although there have been cases which verge so closely upon it that the point is worth considering in relation to the future. There is no more reason why an unreasonable employee or group of employees, who have a fixed notion regarding some particular point, should be permitted to have their own way against the decision of their representatives or to unreasonably waste the time of the Commission's officers, than that some department official should be allowed to block a settlement which is just and reasonable in the eyes of collective management. The Plan is intended to prevent any individual or small group of individuals from prejudicing the common interests of employees and management, and if it is to do this the stubborn individuals who obstruct must be overruled.

In the matter of recognition of authority, management is now much better equipped than is the employee body. Official decisions are not challenged by dissenting management minorities; there may be minor differences in interpretation but a word from the proper official will promptly straighten them out. Moreover, the issues involved in employee-management problems do not directly affect the management representatives; in this sense their views are impersonal and less likely to be subject to sharp dissension.

On the other hand, while employee representatives are invested with such authority as may be necessary for the purposes of the Plan, the employees are not fully accustomed to the idea of having them exercise it.

Employee reactions are highly personal; the first thought of the great majority is—How will I be affected? While this is natural, it has its complications. Consider the diversity of views among several thousand employees, many if not most of whom lack the information that is essential to a comprehensive view of the subject about which they are concerned. Consider also the variety of irreconcilable views and conclusions that must be reached under these circumstances and the difficulty of harmonizing such a diversity of opinion. No wonder it is one thing to appoint representatives and quite another to be satisfied with their decisions and undertakings. Yet how else can the work be carried on?

Let us quote two examples, one of the highly personal element and the other of incompatability in employees' views:

> A number of men who have identical duties and responsibilities and are paid exactly in accordance with the new schedule learn of another of the same occupation who, through an error, has been allowed too much service credit and consequently is somewhat overpaid. Result—dissatisfaction and a demand that the wage of the overpaid employee be reduced to the proper rate. Something very much akin to jealousy is at the bottom of the urge to effect a reduction in these circumstances; certainly the reduction is of no benefit to the employees at large. Again, please do not misunderstand. I do not say that the adjustment is not justifiable and logical—only that it illustrates a highly personal and individualistic viewpoint which in certain other directions is difficult to contend with.

> As an illustration of the incompatibility of certain group or sectional employee views, the case of operators vs. maintenance men may be cited; we find the operators of the Niagara System high tension stations presenting a formal complaint that their wage schedule is too low compared with the maintenance men, while the latter are complaining with equal emphasis, though not in writing, that the reverse is the true state of affairs.

One could cite innumerable examples which illustrate the fine distinctions drawn by employees where their own personal interests are concerned. Individual claims are made that special wage plusses should be allowed for this small thing and that, overlooking entirely that if the Commission made similar minus deductions they would be considered most unjust and, what is more important, overlooking the complexity and loss of clearly-defined schedules into which these rather petty considerations would lead. Carried to the ultimate conclusion they would result in such a multiplicity of rates as to be utterly unworkable—a situation which is just what the employee group has sought to escape. Every man has his own ideas about these fine distinctions and they are often utterly incompatible with each other.

I have endeavoured to impress upon you the difficulty, which amounts to impossibility, of dealing with individuals and of satisfying every one, and to draw attention to the utterly irreconcilable nature of some of the requests and contentions that are advanced. No individual or sectional group is in a position to think impersonally and to speak without bias about the affairs which vitally concern themselves. I hope you will reflect on this, and realize that after careful consideration in committee and subsequent negotiations with management your representatives should have a much broader knowledge, comprehensive viewpoint and appreciation of what is practicable than any individual or sectional group can possibly have. Individuals must learn to distrust their own judgment about their own claims and re-

member that it is quite impossible to completely satisfy everyone.

The only practicable course is to place responsibility upon your representatives, give them authority, abide by their commitments and stand behind them in case of sectional dissension. The collective view is the only sound one.

### DISTRICT JOINT CONFERENCES MANAGEMENT SHORTCOMINGS

I would like to acknowledge here the regrettable fact that District Joint Conferences have not functioned as effectively as had been hoped, very largely through the fault of management. I need not tell you that the Plan originated at a time when management was beset by many troublesome questions; owing to the existing stress it was not possible to give the full amount of attention to everything that was required for successful performance. In these circumstances, management representatives on the District Joint Conferences were not given the kind of instructions which would enable them to deal promptly and efficiently with the problems with which they were confronted. Steps are now being taken to correct this shortcoming and I am hopeful that, in future, District Joint Conferences will fulfil their intended function and effectively dispose of a great many of the questions which come before them, thus relieving General Joint Conference of a great many needless items.

Employee representatives can also do something to make District Joint Conferences more successful:

They can weed out frivolous and unjustified complaints in committee. This is within the intended scope of their authority and is very necessary, not only to avoid unnecessary wastage of Joint Conference time but to give evidence of a proper sense of responsbility on the part of employee representatives.

They can help by endeavouring to have available complete information in relation to each item of the agenda and whenever possible by giving management representatives advance notice which will enable them to look up information in advance.

And they can remember that while it is appropriate to talk over matters of general concern to all employees in District Joint Conference and to tentatively sound out management views, in the very nature of things some of these matters can be dealt with only after the General Committee of Employees and the General Joint Conference have had an opportunity to pass upon them.

### DISSATISFACTION AND CRITICISM

It is inevitable that some of the appeals put forward under the Plan will be rejected and it is probable that some employees will feel that rejection of their claims is unfair and may be tempted to berate the Plan and criticize the employee representatives and the management for what appears to them to be unwarranted failure. I have already pointed out that the accomplishments of the Plan should be viewed collectively, not individually. It is typical of certain individuals that if they do not get their own way they are prepared to throw every one else overboard and

attempt a fresh start in any new direction, which, in their opinion, offers greater promise of success for themselves. I suggest to you that those who feel most aggrieved may feel that way because they expect too much. Fortunately my information leads me to conclude that the number of unduly dissatisfied individuals is comparatively small.

It takes time to study all the complex angles of the employee-management problems in a large organization such as the Commission's. In many instances, delays are inevitable. If we are to attain the maximum of success we must not be too impatient. It may surprise you to know that many organizations which are no larger than the Commission's have required a *very* much longer time to put similar plans into effect than the Commission has taken.

BENEFITS—MUTUAL AND COLLECTIVE

It is natural that employees should be keenly interested in the returns that they receive for the services which they give the Commission and perhaps that they should seek to compare those returns with the compensation which similar services bring elsewhere. When doing so it is easy to overlook some of the indirect benefits enjoyed by permanent Hydro employees. First there is the Pension and Insurance Plan with its provision for permanent disability and retirement at sixty-five as well as its insurance feature, only a portion of the cost of which is paid by the employees. Next there is the security of the so-called permanent Hydro positions. As you know, these positions are practically depression-proof, partly because of the stability of the power enterprise but also partly because of the effort which the Commission makes to properly take care of its permanent staff. Then there is the sickness benefit, which, while not subject to specific regulations, is, nevertheless, administered on broad humanitarian lines. Among the more recent advances in working conditions in the field, we have the granting of two weeks annual vacation with pay, statutory holidays with pay or equivalent time off, the standard 48-hour week and one day of rest in seven. Last, but far from least, we have the establishment of a job classification and wage schedule under which the proper wage for a great many of the Commission's positions is definitely specified and a good guide is furnished as to the appropriate wage for practically all the remaining positions, and as a result of the schedule substantial increases in the annual wage disbursement have already been made.

When these accomplishments of the last two years are considered impartially, they surely give convincing evidence of progress and when one considers the machinery provided by the Plan for negotiation and the evident spirit of co-operation which is being displayed both by the management and the employee representatives, it seems to me that you have no occasion to look to the future with apprehension.

The advantages that will accrue to the Commission remain to be considered. The Commission automatically benefits through improved employee-management relations but it

will not derive the full benefit unless the employee group gives thoughtful attention to ways and means of increasing the sense of responsibility and desire on the part of employees to give their best to their work; not only their best in the matter of exercising their skill and intelligence, but their best also in a co-operative effort to adapt themselves to the Commission's organization and help to make it function as a purposeful unit. This calls for team play and team play calls for the subordination of self in the interests of the team.

Even in industry it is not always easy to recognize that team play is best for each individual as well as for the team. In sport, grandstand plays may be tempting to a player who craves applause, but in industry services are evaluated with a more discerning eye and high marks are given for team play so that in the end it is in the interests of each individual as well as the team to strive for co-ordination and increased overall efficiency, for, as overall efficiency improves, higher wage levels are justifiable. Keep in mind that this institution is operated in the public interest, not for the special benefit of the staff. Its trustees, the Commission, should be fair to the staff but should not pay you less or more than is justified by your performance. I believe that it is in the public interest to pay good wages to a body of employees that gives generously of its best and I am asking you, tonight, in the common interest of the Commission and yourselves to give careful thought to this question of your production and to remember that the sound basis for any claim for reward or advancement is excellent service.

Tonight I have tried to give you food for thought. I hoped that a frank statement of the facts as I see them would be of lasting benefit by helping to direct your attention and efforts into channels most likely to bring results and by giving you an opportunity to voice your opinions when they differ from mine, for it is by these means that we shall progress.

Please do not mistake my remarks about previous shortcomings as criticism or think they arise out of irritation or pessimism—far from it. I am not only hopeful but confident of the future. The work already done is now undergoing the acid test of practical application which brings to light faults and virtues as nothing else will. After careful review and mature reconsideration, such adjustments in established wages and working conditions as may be appropriate must and shall be made and, from time to time, phases of working conditions not yet dealt with will doubtless be invaded.

My life work has been devoted to Hydro. Hundreds of the staff are well-known to me, many of them as personal friends and I have only the warmest and best wishes for every one of you. Among other things, I wish you all a Very Happy New Year, a fair solution of our mutual problems, and very happy relations in all our future co-operative efforts.

# Ivan N. Pritchard, Chatham

The Chatham Public Utilities Commission suffered a great loss to its personnel in the sudden passing of its Secretary-Treasurer, Ivan Noah Pritchard, at St. Joseph's Hospital, Chatham, on Friday, January 14th, 1938.

Mr. Pritchard had not been in the best of health lately but no alarm was felt over his condition and when he decided to have an operation to correct some stomach trouble, it was not considered serious. However, a few days after the operation his condition changed suddenly and he passed away within twenty-four hours.

The City of Chatham as a whole has lost a very reputable citizen as Mr. Pritchard spent his whole life here, being born in the city 43 years ago. His family has always been prominent in Municipal affairs, his father being a member of the Council for a number of years.

He started in to work for the Chatham Public Utilities Commission when it was inaugurated in 1914 and had a very intimate knowledge of the operations of the Commission. He worked up through the various positions in the General Office work and in 1929 was appointed to the position of Secretary-Treasurer of the Commission, which position he held until his death.

In respect to outside activities he was a member of the Kiwanis Club and held the position of Secretary of that organization for some years. He was also interested in Boy Scout work and was a member of the Boy Scout Council of the city for a considerable period of time.

*Ivan Noah Pritchard*

He also took a great interest in Provincial Hydro activities, being a member of the A.M.E.U. and in it has been a valued worker on the Merchandising, Accounting and Office Administration Committees. His presence will be missed at the conventions of the future.

Surviving Mr. Pritchard are his widow, Mrs. Leta M. Pritchard and two sons, Beverley and John, one brother, Vernard, and one sister, Mrs. Anthony Hewitt, all of the City of Chatham.—*R.S.R.*

# Resuscitation by Employee of Carleton Place Public Utility Commission

On July 7th, 1937, at Carleton Place, Ontario, a young girl, five years of age was playing on a raft near the Power House and fell into the river. Stewart Ferguson, fully clothed, dived in and he was followed by Lionel Bigras who was in a bathing suit. After about seventeen dives, the child was eventually brought to the surface and was taken from the water.

Wilfred Bigras, a lineman with the Carleton Place Public Utility Commission, immediately started Artificial Respiration. As a result of the Artificial Respiration, the child started breathing in about half an hour. Due to the severity of the shock, it was necessary to give her hospital and medical care for some days.

This is a case of a person under water for at least five minutes, being resuscitated and when breathing, turned over to doctors for necessary after-care; surely a clear case of the value of training and continued practice in the Prone Pressure Method of Artificial Respiration.

*Wilfred Bigras*

The National Safety Council awarded the President's Medal for Meritorious Safety Service to Wilfred Bigras. The Royal Humane Society awarded certificates to Lionel Bigras and to Stewart Ferguson for the rescue.

A public meeting was held in the High School at Carleton Place on December 16th, 1937. This meeting was under the chairmanship of M. W. Rogers, Manager and Secretary-Treasurer of the Carleton Place Public Utility Commission and was attended by members of the Commission, of the Council, a class of the St. John Ambulance Association and interested citizens.

The President's Medal was presented to Wilfred Bigras by Wills Maclachlan acting for the President of the National Safety Council with headquarters in Chicago.

# THE BULLETIN

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# The Municipalities and the Hydro Scheme

**By the Honourable W. L. Houck, B. Sc., Vice-Chairman, H.E.P.C. of Ont.**

*(Address to the Ontario Municipal Electric Association and the Association of Municipal Electrical Utilities at Toronto, February 8, 1938.)*

IT gives me a great deal of pleasure, on behalf of Commissioner Smith and myself, to extend welcome and sincere good wishes to delegates representing our partner municipalities in this province. Because I know your program is a rather extensive one, and in order that I may not take up too much of your time, I will limit myself to only a very few pertinent observations.

Up to the present time my only association with municipal representatives has been with groups of perhaps two or three. Never before have I had the opportunity of meeting such a large number of you gathered together at one time and place, and I must confess myself impressed not only by your numbers but by the number of people which as local hydro commissioners you serve, and of the money value of the asset the destiny of which you control. Actually there are 561,254 customers of municipal electric utilities within this province, receiving power supply through an aggregate municipal plant asset valued at $93,438,204.30. These figures are illustrative of your importance in the great general hydro scheme.

You will observe that I have said the great general hydro scheme, and I have done so because actually there is only one hydro scheme. True, there are two sections, two jurisdictions,—that is to say, the provincial and the municipal authority, but ultimately we are advancing along parallel lines and as we proceed our paths continually cross and re-cross. Our differences are only purely mechanical matters of jurisdiction and administration. That we concentrate on separate items in the com-

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**Vol. XXV No. 2**

**February, 1938**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

posite buying and selling operation does not obscure the fact that ultimately we serve the same people. Our points of difference are accordingly merely incidental, purely mechanical and not fundamental, and in the great general Hydro set-up most certainly not of basic importance. Ultimately the expenses of both jurisdictions combine and enter into the same electric light bill of the same ultimate consumer, and we have accordingly a like responsibility which we must fulfil in like manner.

We cannot exist separately under the present set-up, and it is therefore to the advantage of those we serve as well as to our mutual satisfaction, that we co-operate in the carrying out of our separate duties.

I have said that neither the provincial or the local jurisdiction can function separately, and perhaps I should amplify and at the same time qualify this a little. It would be possible under a different set-up for a provincial body to administer the generation and purchase of power and as well its retail distribution. On the other hand were there no provincial body each municipality could itself attend to the generation or purchase of power in sufficient quantities for its own customers. But neither of these alternatives is completely practical, because of the additional expense which in the final analysis each would incur against the consumer.

There is a very real advantage to all in a co-operative scheme of electrical supply. The principle of mass production enters into the picture and effects a levelling downward of the cost of individual items. Quite obviously the cost of power will decrease if a number of municipalities combine in the use of one piece of apparatus or equipment—one powerhouse or one transmission line. This, I think, has been well-illustrated in the past. As a greater number of municipalities have availed themselves of the benefits of electric power the average cost has been reduced, and very materially. The first feature in a co-operative scheme of electric supply is, accordingly, its economy.

But there are other features which though not quite as tangible are

equally important. I refer to the additional protection assured to each municipality by a pooling of power resources. It would be quite impossible for each municipality to maintain two power plants, or two transmission lines. Certain power and equipment reserves would, as a matter of prudent business practice be maintained in service, but in all instances the question of economy would enter into the picture and limit expenditures in this direction. Permit me to ask just what would have happened if two weeks ago one or two municipalities were solely dependent upon power from the Ontario power plant on the Niagara river. Supply would have ceased, immediately and in its entirety, and for a matter of months residents of those municipalities would have been deprived of light for their homes and power for their industries.

Under a co-operative scheme this contingency while not at any time beyond possibility, is a rather remote one. A greater amount of protection is added, and the interchange of power is effected on a large scale.

The alternative I have proposed to you, the individual generation and supply of power by individual municipalities can accordingly be discarded, not only on the latter ground but on that of economy as well.

The other alternative, that of supply by a provincial body in its entirety can, I think, be discarded on equally positive grounds.

In many ways local authorities are best able to judge on power matters. Conditions vary in different localities. The saturation point of a certain community or group in a community is difficult to establish from a distance, and accordingly local authorities are best in a position to determine in what direction their greatest effort should centre, in order to assure maximum productivity.

Not only so, but the main objection to a body such as I have suggested lies in the arbitrary power which it would necessarily possess. Democratic administration is the very essence of public ownership and under the alternative I have mentioned it might disappear. It need not necessarily do so, but it might. It is not always possible to visualize what individuals might do under certain circumstances, and it would accordingly seem to the advantage of the consumer that the jurisdiction entering into the supply of power be a divided one.

Our present set-up would therefore appear to be sound in principle. Its administrative features are such as to lend themselves to efficient management, and while it may not be the best scheme that could be evolved, I think I am safe in saying that it is the best yet to be evolved.

These are things which you have undoubtedly heard before, but there is nothing lost in telling them again. Co-operation of the varying jurisdictions entering into electric supply is the very principle upon which hydro was founded and upon which it has extended and prospered in the past. There have been mistakes made and recriminations have resulted from those mistakes, but in each instance I venture to suggest that the mistakes

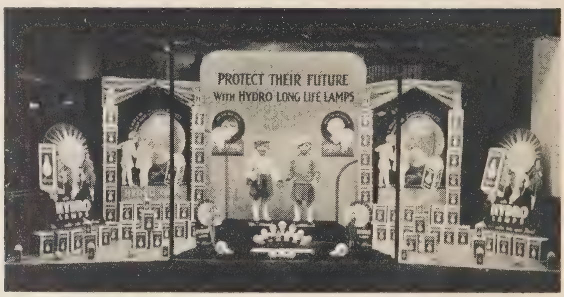
have occurred not as a result of the carrying out of the principles of supply, but rather as a result of an intentional or unintentional disregard of its principles. It is the earnest hope of this commission that the co-operative feature of hydro supply will in the future be continued and extended, to the enduring benefit of the community.

# Hydro Lamp Window Dressing Contest Awards

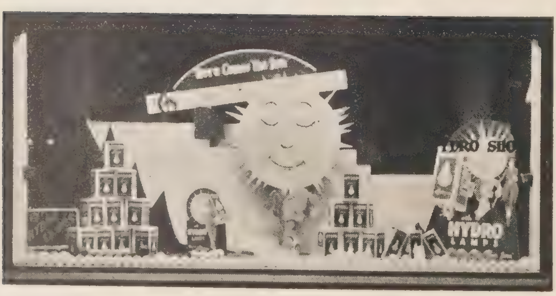
## Class 2

The Class 2 awards in the 1937 Annual Hydro Lamp Window Dressing Contest, shown herewith, represent the efforts of those Hydro Shops located in cities of less than 100,000 population.

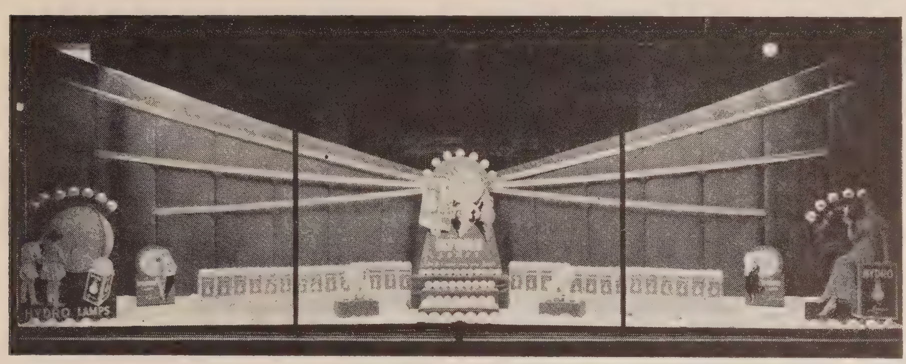
These display creations rival those of Class 1 as to their excellence and have proved to be real selling windows.




*First Prize, Class 2, Belleville Public Utilities Commission.*




*Second Prize, Class 2, Chatham Public Utilities Commission.*




*Above — Tie Third Prize, Class 2, Oshawa Public Utilities Commission.*

*Right — Tie Third Prize, Class 2, Kitchener Public Utilities Commision.*

## Janet Cameron, Brockville

Suffering a fall on the preceding Sunday, Miss Janet Cameron, accountant in the offices of the Brockville Public Utilities Commission, passed away on Wednesday, February 2, 1938, in her eighty-fourth year.

Miss Cameron was born at Perth, coming to Brockville more than fifty years ago. A short time later she joined the staff of the water works company as bookkeeper and remained in that capacity with the succeeding Public Utilities Commission. After approximately forty-eight years of faithful and conscientious service, she resigned at the end of 1937. She remained on duty, however, to instruct her successor. On leaving the office on the Saturday before her death, she had remarked that after another week her successor would be sufficiently conversant with the work to no longer require her instructions. She had planned to take a real holiday to begin immediately after she had finished her work.

Despite her advanced years, Miss Cameron was in good health, and her sudden demise came as a great shock to the Brockville office staff, who will miss her keenly. In the performance of her work she proved herself extremely capable and alert right up to the last, and her books were kept in splendid condition.

# Power Resources and Requirements
## in relation to the
# Quebec Power Contracts Settlement

By Dr. Thomas H. Hogg

*Address delivered at the Annual Meeting of the Ontario Municipal Electric Association and the Association of Municipal Electrical Utilities on February 8th, 1938.*

DURING the past few weeks, as I have been thinking about what I should say at this meeting, I have become impressed with the fact that this winter convention of the Ontario Municipal Electric Association, meeting in conjunction with the Association of Municipal Electrical Utilities, affords probably the best opportunity of the year to place before those most concerned the essential elements of the problems with which the Commission has to deal, and the considerations which have governed the formation of policy and underlie the conclusions reached.

I need not emphasize to you, who are so closely in touch with the municipal side of the Hydro enterprise, the value of a cordial and harmonious relationship between the Commission and the municipalities, collectively and individually. Nor do I need to point out, that this desirable relationship cannot be developed to the full without mutual understanding and sympathy. On the part of the municipalities there must be knowledge and approval of the broad outline of the Commission's policy, and on the part of the Commission a willingness to grapple with the problems of the individual municipalities with an open mind.

Now while I have briefly mentioned these more or less self-evident facts I know quite well that were I in your place I should not be greatly impressed by a discourse on co-operation from the new Chairman. I should look for, and expect to find, evidence that the Commission is determined to give constructive leadership in this regard. May I say, therefore, that to the best of its ability this is precisely what this Commission intends to give, confident in the assurance that the municipalities will meet it halfway, and that it will receive in full measure the support which its accomplishments in this direction may merit. These considerations, therefore, need not further detain us to-night.

As you all know, the Commission recently took action in a matter which, over a number of years, has been the subject of animated public discussion and controversy. I refer, of course, to the settlement with the Quebec power companies. As the consequences of its action are far-reaching and of great importance to the citizens of Ontario this matter will form the central theme of my address this evening.

In order to furnish the background necessary to a proper appreciation of the reasons for making the settlement, it is necessary to present in some detail several aspects of the power situation in Ontario. This in itself is no small task, for two reasons, first because certain aspects involve technical considerations of more than average complexity, and second because there is much popular misconception attributable to contradictory statements many times repeated during the prolonged controversy. For these reasons it has become evident to me that a somewhat comprehensive presentation of the facts and a careful interpretation of their significance are essential if I am to convey to you, an understanding of the reasons for making the settlement.

First, we shall survey the sources of power in southern Ontario.

### POWER RESOURCES

The hydraulic power resources belonging to the Province of Ontario which are now susceptible of economic development for use in southern Ontario are to be found on the Ottawa, Madawaska, St. Lawrence and Niagara rivers. The last named is used in a special sense to denote any power resource obtainable from water in its descent from lake Erie to lake Ontario, thus including the development at DeCew Falls. There are also certain smaller water power developments available, such as those now being developed on the Musquash river. Power supplies large enough to meet the annual growth in demand of the Niagara system must, however, come from large developments. The developments possible on the Madawaska river are more suitable to meet the lesser demand of eastern Ontario. In the main, therefore, southern Ontario's hydraulic resources are on the Ottawa, St. Lawrence and Niagara rivers. In addition, there is always the possibility of having recourse to steam as a source of power.

### *St. Lawrence River*

Ontario's interest in the St. Lawrence river water power lies in the international portion of the river, in which the ownership of power and jurisdiction over its development, is vested in the Province of Ontario and the State of New York.

Large power developments on the international stretch of the river require the construction of permanent dams across the river with sluices for the regulation of flow, and with permanent navigation locks and other works; in consequence, on this portion of the river power development is inseparably linked with navigation which, of course, comes under the jurisdiction of the respective federal governments of Canada and the United States.

The St. Lawrence power and canalization projects constitute an international undertaking of great magnitude, concerning which there is ample room for widely varying opinions throughout the United States and Canada, according to sectional interests or local viewpoints, and wide scope for political issues to arise as a result of differences of interests and opinions. These divergent interests, opinions and views have interposed a hitherto insuperable obstacle in the way of the St. Lawrence project; for although on one occasion the four interested parties did reach an agreement in stated terms, it has

never been possible to secure the necessary authorization to proceed.

Quite aside from this inability to agree to take concerted action and the consequent uncertainty as to the time when the work might be commenced, St. Lawrence power, as a source of supply to take the place of the power provided for by the Quebec contracts, must be definitely rejected for another reason, namely, the time required for the actual construction of the works. This project is so large that no reliance can be placed upon obtaining power from it for five or possibly six years from the time commencement of work is authorized. It is probably fair to say, that there has never been a time when there appeared to be any real likelihood of obtaining power from the international portion of the St. Lawrence river in less than seven years. Although this Ontario power resource is of very great potential value for the future, its existence has not had, and could not have, any bearing whatever upon the recent Quebec power settlement.

You will readily appreciate that no reasonable business man, charged with the responsibilities of administering The Hydro-Electric Power Commission of Ontario, would be justified at the present time in placing any reliance upon obtaining power from the international section of the St. Lawrence river for use during the period for which the Quebec power was purchased.

### *The Ottawa River*

The descent of the Ottawa river from lake Temiskaming to the St. Lawrence river is made in a series of falls and rapids which occur throughout its course, affording splendid opportunity for low-cost water power development. There are upwards of a dozen excellent sites which aggregate in capacity some 1,200,000 horsepower. As this portion of the river constitutes the boundary between the provinces of Ontario and Quebec, one-half of all the power belongs to Quebec and the other half to Ontario. Of the total interprovincial resources about one-third has now been developed; Ontario's share of what remains is approximately 480,000 horsepower.

Three governmental bodies exercise a measure of administrative control over the Ottawa river; the legislatures of the two provinces and the parliament of the Dominion of Canada. The jurisdiction of the Dominion arises out of its control of all matters affecting navigation, and of the provinces through their ownership of the bed of the river and the adjoining lands. There have been differences of opinion between the provinces and the Dominion concerning their respective rights and at one time the Dominion granted charters, notably to the Montreal, Ottawa and Georgian Bay Canal Company, and the National Hydro-Electric Company, Limited, purporting to convey rights to develop power; this was disputed by the provinces. Before the development of Ottawa river powers could be undertaken many of these complex issues, including the division of water between Ontario and Quebec, had to be settled through tedious and time-consuming negotiations. These contentious issues were not settled to the satisfaction of the provinces until

1927, after which the way was clear for development at Chats Falls.

Notwithstanding the settlement of contentious issues as to the *right* of jurisdiction, there are still difficulties in the way of making further developments under present conditions. Owing to the unavoidable *division* of jurisdiction between legislative bodies, and the resulting legal complexities, the procedure incidental to development is so involved that it is impossible to state it briefly and accurately. It is clear, however, that at least two conditions must be fulfilled before power development on the Ottawa river can be undertaken:—

1. There must be two parties, one in Ontario (The Commission) and the other in Quebec, who desire to proceed jointly on terms which are agreed upon.
2. The co-operation and consent of both the provinces of Ontario and Quebec must be obtained.

I scarcely need point out that it would have been impossible to fulfil both of these conditions while the Quebec power contract situation stood as it did prior to the recent revision and while an unused surplus of power existed in Quebec or while Quebec demands could be supplied from any sources alternative to and comparable with the Ottawa. Therefore, power from Ontario's undeveloped resources on the Ottawa river could not be an immediate alternative to additional power provided by the Quebec contracts settlement.

*The Madawaska River*

The Madawaska river is a tributary to the Ottawa, and enters it at Chats lake about 35 miles above the city of Ottawa. Its numerous power sites are not only favourably situated but they are also very suitable as to size in relation to annual load increases, for development as sources of 60-cycle power for the Eastern Ontario system. With development of the storage obtainable the undeveloped sites would produce about 140,000 horsepower when operated at load factors characteristic of the Eastern Ontario system, and somewhat less if developed at 25 cycles for the Niagara system. Recently the Madawaska river has been depicted as one of two sources of power supply for the Niagara system which were said to secure the Commission against the need for any more Quebec power than it had agreed to take prior to the recent Quebec contract revisions. It will be apparent later that Madawaska power either by itself or in conjunction with any other hydraulic power resources at the disposal of the Commission prior to the settlement with the Quebec companies, would not have provided a supply which could be relied upon to meet the Niagara system power requirements, during the next five years; on the contrary, there is every probability that the development of this power resource at 25 cycles for the Niagara system would only have served to defer for one year or at the outside for two years, final recourse to power from Quebec sources or, in the alternative, power from steam. Having these facts in mind would it have been wise to incur the risk of an unfavorable issue to the litigation in progress by refusing to

negotiate a settlement of the Quebec power dispute?

*Niagara River*

While a survey of the prospect of obtaining additional power from the Niagara river yields little better assurance of early results than from the St. Lawrence and Ottawa rivers, the many complex angles which must be touched upon require a more lengthy explanation.

There is the question of diverting additional water from above the falls at Niagara, at present governed by Treaty. Linked with this is the possibility of actually increasing the flow available to Canada by adding to the Great Lakes supply through the Long Lac and Ogoki diversions.

There is the possibility of extending the Ontario Power plant, of making a second full head development at Queenston, or developing 25-cycle power at DeCew Falls.

There are also the possibilities of constructing a purely peak power plant at DeCew Falls; of increasing the peak load capacity at Queenston by a scheme involving pumping at times of low demand during the night, or of increasing the capacity of the development by the use of flow-booster pumps in the canal.

Apart from physical proposals there are matters of Treaty revisions and of adjustments in export arrangements. When it comes to specific courses, these many features have a tendency to intermingle and combine into innumerable combinations which cannot even be suggested in the time available.

*Treaty Diversions at Niagara*

Under the Boundary Waters Treaty of 1909 between Canada and the United States it is provided that "The High Contracting Parties shall have, each on its own side of the boundary, equal and similar rights in the use of . . . . . . . boundary waters". Thus the benefits derivable from the use of boundary waters belong equally to both countries. In the case of the Niagara river, however, a number of considerations led to a special apportionment of the water to be diverted for power purposes, as a result of which authority was given to divert 20,000 cubic feet of water per second on the United States side of the river and 36,000 cubic feet of water per second on the Canadian side. The difference in permissible diversion on the Canadian side was offset by the exportation to the United States of electrical energy developed in power plants on the Canadian side of the river.

From time to time efforts have been made, under various schemes, to increase these quantities and, in order to preserve the scenic beauty of the falls, which was a primary reason for the Boundary Waters Treaty, river works have been proposed to maintain a satisfactory distribution of the water over the crest of the falls. One such definite scheme was made the subject of a Convention and Protocol which was drawn up in 1929. The plan provided that the remedial river works be constructed at the expense of the Hydro Commission and the Niagara Falls Power Company, in return for which they were to be allowed to use, in existing generating

equipment, an additional 10,000 cubic feet of water per second but only on a trial basis during six winter months and for a period of seven years. This convention, however, failed to obtain the assent of the Foreign Relations Committee of the United States Senate.

This illustration is cited to show the difficulties of securing consent to even modest revisions of Treaty terms. It is, therefore, essential to an understanding of the Niagara problem to bear in mind that no water in excess of the amounts provided by treaty can legally be used for power on either side of the boundary, except by international agreement. There is no escape from this on any pretext or argument.

At Niagara Falls, New York, and throughout a large portion of that State, power distribution is under the control of the Niagara-Hudson Power Corporation which has been anxious to secure the right to develop more power at Niagara Falls. There is also an influential and active public ownership movement in New York State which seeks to implement the development of the St. Lawrence by or for the State and it is inevitable that the two should be opposed.

If you will reflect upon the forces in New York State which are pressing for early state development of the St. Lawrence for power, and other interests more particularly in the western states which have been pressing for the navigation aspects of the St. Lawrence project, you will see that while this issue is active, the prospect of a revision of the Boundary Waters Treaty, to permit the use of additional waters for power development at Niagara Falls, is uncertain, to say the least. As a matter of fact the prospect does not appear to be any brighter now than it did in 1924 and 1925; it is simply out of the question to place any reliance upon it.

*Diversions Into the Great Lakes*

Notwithstanding the apparently insuperable difficulty of obtaining, at the present time, increased diversion at Niagara by treaty revision, it was hoped that if purely Canadian waters were artificially diverted into lake Superior, an equivalent quantity of water might be put to use down stream in the Niagara and St. Lawrence rivers for the exclusive benefit of Canada, without the formality of treaty changes. The facts of the matter appear to be that if Canada were to divert its waters into the Great Lakes without formal international agreement, the United States might be entitled to an equal share in the benefits derivable at all points in boundary waters except at Niagara Falls, where, due to the specific treaty limitations on diversion from above the falls, neither country could benefit. To proceed with the Long Lac and Ogoki diversions without official international safeguards would actually jeopardize the possibility of obtaining for Canada the exclusive use for power development of the diverted waters and it would do this without securing any immediate additional power benefit.

*The Long Lac and Ogoki Projects*

Perhaps a brief description of the Long Lac and Ogoki projects will be of interest. The Long Lac

project involves the diversion of the run-off from the southerly portion of the Kenogami river watershed, from its natural outflow into the Albany river and James bay, to lake Superior, passing along a channel cut through the height of land, and down the Aquasaban or Black river. This particular portion of the Kenogami river watershed is very close to lake Superior, the nearest point of the divide being less than thirty miles from the great lake. The proposal is a combined water diversion and pulpwood transportation scheme which would enable large quantities of pulpwood from the Long Lac watershed to reach lake Superior. Work on this scheme was well under way but was shut down in December, 1937.

The Ogoki river diversion is a somewhat larger project. This river is one of two principal tributaries to the Albany. By constructing a dam at Waboose rapids to raise the water level some 35 feet, the run-off from the watershed of the Ogoki above this point can be diverted across the height of land into the chain of lakes leading to the Jackfish river and thence through lake Nipigon down the Nipigon river to lake Superior.

Theoretically, of course, these two diversions add nothing to Canada's potential water power since the fall of the water to sea level is the same whichever route is followed but if diverted southwards, instead of passing through an unsettled and largely undeveloped territory, this water would pass along the side of the greatest power consuming area of the Dominion, over falls and rapids affording better power sites than exist on the northern route.

In passing to lake Superior the Long Lac diversion of approximately 1,100 cubic feet of water per second would permit development on the Aquasaban or Black river of about 20,000 horsepower. The Ogoki diversion of 4,000 cubic feet of water per second would add about 90,000 horsepower to the potential power of the Nipigon river. Passing through the outlet of lake Superior at Sault Ste. Marie, the combined diversion of say 5,000 cubic feet of water per second would if used, produce 10,000 horsepower. On the Niagara river, if utilized in a second full-head development at Queenston, the extra flow would provide 150,000 horsepower. Continuing down the St. Lawrence 40,000 horsepower would be added to the power resources of Ontario and 50,000 horsepower to those of Quebec.

### *Other Schemes for Additional Power From Niagara*

Time will permit only a mention and the briefest comment respecting other schemes for obtaining additional power from the waters which pass, either by the Niagara river or by the Welland canal, from lake Erie to lake Ontario.

The most effective is a second full-head development, not unlike Queenston, in the sense that it would use in a single stage, the head available from above the upper rapids to below the rapids of the gorge at Queenston. To attain the desired efficiency and economy it would have to be a large development, utilizing

at least 10,000 cubic feet of water per second to give a minimum of 300,000 horsepower. As pointed out, there is little immediate prospect of such an additional flow being secured by treaty revision. By expropriating the Canadian Niagara plant and utilizing this water supply in a more efficient plant, using the full head available, about 200,000 horsepower, over and above the 100,000 horsepower at present generated in this plant on the Canadian side chiefly for export, could be obtained, but the change would necessitate the virtual abandonment of the Canadian Niagara plant and at present this is not economically attractive, partly because it would be necessary to construct an expensive 300,000 horsepower capacity plant for a net gain of 200,000 horsepower.

Moreover, Canada is not free to proceed with any development or any modification of existing developments which involve the diversion of additional water around the gorge between the falls and Queenston without consulting the interests of the United States. In a note dated April 6, 1916, submitted by Robert Lansing, the United States Secretary of State, at the time the original Queenston development was proposed, such a protest was made. Although this protest was later withdrawn, there is reason to suppose that under present conditions, any attempt on the part of the Commission to increase the diversion around the gorge would give rise to a further and perhaps more serious protest from the United States.

The extension of the Ontario Power plant would also involve additional diversion at the falls, but not through the gorge.

With regard to DeCew Falls, the Department of Transport is willing to study the feasibility of allowing the Commission to take additional water from the Welland canal for use at the DeCew site only after the international aspect of the use of additional water is settled. In the course of time some 700 cubic feet of water per second now leased from the old canal will be available. However, the present 50,000 horsepower, 60-cycle plant at DeCew Falls, with its storage basin, makes effective use of all the water now available.

An alternative suggestion has been made that a purely peak load plant of 200,000 horsepower capacity be constructed at DeCew Falls, utilizing only the present available flow. Such a plant could only operate for some three hours per day, and, therefore, some other source would be needed to supply the base load during the twenty-one hours when the peak load plant could not operate. Previous to the settlement of the contract issue, the relationship between the amount of peak power and daily energy available from the Commission's then resources closely approached the relationship between the maximum peak day demand for these quantities, and, therefore, insufficient quantities of excess energy were available to make this development economical. As additional quantities of Quebec power, with their comparatively large amounts of energy per horsepower of contract demand, are incorporated in

the system's resources, a surplus of energy which can be used for this purpose will gradually accumulate.

Another source of purely peak power which has been brought forward is referred to as the Queenston forebay scheme. It involves pumping water from the forebay during the low load hours of the day into an artificial reservoir constructed adjacent to the forebay, and using this stored water to operate additional turbo-generators at the time of peak demand. As in the case of the DeCew Falls peak development, the usefulness of this scheme is dependent upon the availability of surplus system energy and for the same reasons is not an attractive alternative to Quebec power.

Brief reference should be made to another proposal to obtain additional power at Queenston. This scheme depends upon effecting an increase in the flow of water through the canal by the use of flow-booster pumps. The canal flow depends upon the difference in water elevation at the entrance and outlet or, as it is termed, upon the surface gradient of the water. By the installation of a huge pumping station at the entrance of the rock section of the canal which would raise the level of the water in the rock section toward Queenston, at the same time lowering it in the earth section near the pumping equipment, the surface gradient would be increased in both portions of the canal thus increasing the flow of water available for the production of power at Queenston without duplicating the canal or constructing a new tunnel. Although there are no insuperable structural difficulties in carrying out this scheme, it has a number of disadvantages that I cannot take time to discuss fully tonight and in my opinion it is unsound from the practical engineering and operating standpoint. Among the disadvantages is the fact that it involves the use of additional water at Queenston which must be obtained either by diverting additional water for power or utilizing a portion of the diversion now employed at the Ontario Power or the Toronto Power plant.*

I believe the foregoing survey demonstrates that the prospects of obtaining large additional power supplies from the Niagara river in the early future are not encouraging.

### *Steam Plants*

The advantages and disadvantages of steam-generated power, as a source of supply to the Niagara system, have been investigated on several occasions, as changes in available system supply and demand have brought this source into question.

One such occasion occurred in 1924-25, when the Queenston plant was approaching its full capacity and there appeared to be no early possibility of obtaining additional supplies from the Niagara, the Ottawa or the St. Lawrence rivers. However, engineering investigation established the fact that power from hydraulic sources in the Province of Quebec, which became available about this time, constituted a more

*The international difficulties respecting diversion of additional water around the rapids of the gorge, referred to on page 49, in connection with a second full-head development, would apply also to the flow-booster scheme here described.

desirable and economical supply than steam power.

Another review of steam power was made in 1935, when the alternatives to Quebec power were being considered with a view to cancellation. At this time, an extensive programme of steam development, totalling half-a-million horsepower over a period of five years, was under consideration.

While these various reviews indicate that steam power has certain advantages; these advantages, from a cost standpoint, are contingent upon the use of steam as a source of peak power at comparatively low load factors. Had the Niagara system been committed to the development of steam power as an alternative to Quebec supplies its continued use might easily have been forced upon the Commission for many years, as there appeared to be no possibility of developing the Commission's own sites on the Ottawa river without first effecting a complete settlement of the Quebec contract issue, and no other source of supply likely to become available in the near future. Under these circumstances operation under conditions favourable to steam development could not have continued for long; instead, the cost of such power would have steadily increased as the plants were year by year called upon to supply increasing quantities of high load factor base demand.

There is an important disadvantage to the extensive use of steam power which is not directly reflected in the cost of its generation. Large electro-chemical and electro-metallurgical industries have been built up in the Niagara district, which depend upon "interruptible" and low-cost "at-will" power supplies. So long as our principal supplies are from hydraulic sources, capable of high load factor operation all the year round, there exists a surplus of energy which may be furnished to these industries with advantage. If, however, a substantial proportion of the system capacity were to be generated in steam plants, this surplus of energy would no longer exist, as it would have to be diverted to the primary supply in order to enable the steam plants to operate at their economical low load factor ratings. The disadvantages in a programme of development which would seriously injure or cripple these industries are obvious.

Finally there is the question of fuel. As Ontario has within its borders no source of fuel suitable for such plants they would be dependent upon foreign fuel, which is not only more expensive than in territories situated near coal mines, but is subject to risks of price fluctuations and actual shortage in supply due to labor troubles in foreign mines and on foreign railways and possibly also to embargoes.

Steam power in limited quantities, for certain special purposes which are not material to our survey tonight, may have a place in the Commission's future supplies, but as an alternative to base power from Quebec sources, it is not competitive.

* * * *

The foregoing review of the potential hydraulic power resources of

southern Ontario, and the serious obstacles which prevent their early development, establishes very clearly the irrefutable fact that such resources could not possibly be counted upon to meet the power demands which may reasonably occur in the Niagara system during the next five years. In these circumstances only two courses were open to the Commission: either embarking upon a programme of very extensive steam power development, or securing additional supplies of Quebec power by adjusting the contracts with the Quebec power companies and paving the way for the development of Ontario's own power on the Ottawa river.

### POWER REQUIREMENTS

To adequately protect the interest of those who are dependent upon any given power supply, the system serving them must possess sufficient resources to fulfil the under-noted requirements:

1st. There must be sufficient capacity to supply the maximum primary power demand.

2nd. There must be continuously available reserves to meet losses of capacity which occur without warning. This may be termed an "emergency reserve".

3rd. There must be power resources available on demand, or obtainable in sufficient time by development or otherwise, to meet the increasing primary demands due to growth. These may be termed "growth resources".

There has been a noticeable failure, in public discussion of power problems, to distinguish between "emergency reserves" and "growth resources". This has caused confusion, for the "emergency reserve" should always be immediately available, while "growth resources" need not be available until required by increased primary demands.

### *Contingencies Which Make Emergency Reserves Necessary*

The operation of a hydro-electric power system affords striking examples both of man's ability and of his inability to control, and direct to his own benefit, the forces of nature. From the generating station, within which is usefully harnessed the power of a Niagara, to the slender strands of the transmission and distribution lines bringing the comfort of electricity to distant parts of a province, the whole system is constantly in conflict with natural forces. On occasions it is inevitable that these enormous natural forces of which winds, floods, ice and lightning are examples, will gain the upper hand, for the construction of a power system which will be entirely immune from structural damage and operating troubles is not economically practicable.

It follows that the decision as to how far to go in the attempt to assure a normal and continuous supply of power becomes a matter of judgment. Those points in the system which are most vulnerable must be determined and given the greatest care and attention. The likelihood of loss or damage must be carefully weighed against the cost of protection and the nature and extent of the safeguards which are economically justifiable must be deter-

mined. Where the cost of complete protection is prohibitive, some risk must be accepted.

Of the various eventualities which may affect the Niagara system, those resulting from great accumulations of ice in the Niagara river probably constitute the most serious threat. The dramatic wrecking of the Upper Arch bridge at Niagara Falls and the sudden and totally unexpected flooding of the Ontario Power plant, involving a loss of capacity of 175,000 horsepower, furnishes the most recent evidence of the seriousness of this contingency.

On only one previous occasion has such a serious loss occurred. That was in April, 1909, when this plant was flooded under somewhat similar circumstances. After that flood, structural changes in the plant were made which afforded protection against river levels ten feet higher than formerly. This was done in the confident though erroneous belief that a similar disaster could not happen again.

Another most serious menace arises from the fact that certain electrical equipment makes use of oil as an insulating and cooling medium. Although designed and built to withstand the explosive forces that may be created under certain conditions, failures in oil-filled apparatus sometimes occur and occasionally dangerous oil fires ensue. In the past such fires have completely crippled the Niagara and Dundas transformer stations. You will recall also the very serious consequences of recent fires in stations supplying the city of Buffalo and part of the metropolitan territory of New York; in both cases a complete cessation of power supply for many hours resulted. Similar fires might cripple any of the generating stations from which the Niagara system is supplied, for it is out of the question to eliminate completely the risk of their occurrence.

Many other emergencies relatively less disastrous in their possible consequences but more frequent in their occurrence may be cited. Among these are low water levels in the upper Niagara river which exercise a marked effect upon the capacity of the Queenston development; accumulation of ice in various forms in plant intakes, which may result in partial or complete loss of capacity; damage to turbine runners which may be caused by foreign substances entering the water passages; breakage of transmission lines, sometimes in situations difficult of access, by accumulation of sleet or occasionally due to intense cold; failure of electric cables or other apparatus, and many other things of like nature. Another less serious example of the loss of generating capacity due to ice conditions in the Niagara river occurred from January 17 to 19 of this year. For some hours these conditions caused a loss of generating capacity of 150,000 horsepower and over a period of fifty hours an average loss of 86,000 horsepower was sustained. These more frequent and less severe occurrences are among the contingencies against which reserve capacities must be provided.

*Extent of Emergency Reserves*

The amount of generating capacity which should be available to offset emergency losses of supply cannot be

determined by any simple rule, such as applying a percentage to the total load. Numerous factors influence the need for "emergency reserves"; among them the relative probability of emergency losses, which is affected by the prevailing standard of apparatus maintenance; the geographical distribution of existing power supplies and the interconnection facilities available. In rare instances the time required to make available for service partially developed resources might have some bearing. The cost of the reserves and the ability to reduce this cost by resale on an at-will basis naturally influences the final decision as to the quantity to be carried.

After a painstaking evaluation of these and other factors in the light of sound economic practice, the Commission has concluded that the Niagara system cannot be assured of a reasonably continuous power supply, under present conditions and under those likely to prevail on the Niagara system for several years ahead, unless it has available an emergency reserve of the order of 75,000 horsepower over and above that capacity which is sufficient to supply the maximum primary power demand. The maximum primary demand, however, includes loads of customers taking power to the extent of about 100,000 horsepower under special contracts, known as interruptible contracts, which embody provisions which permit the Commission to interrupt the supply at certain times and for stated periods during the winter months. In effect, therefore, the maximum primary power demand includes a peak power reserve of 100,000 horsepower which constitutes a second line of defense. As the right to interrupt this power is limited, it is really a high grade supply and is sold for only a little less than firm power. The two combined are commonly referred to as "primary" power.

*Energy*

Since the primary demand includes this 100,000 horsepower of interruptible power, it might be supposed that power resources 100,000 horsepower less than the total primary demand would be quite adequate and that anything more is reserve and only reserve. This is entirely wrong because it ignores another aspect of power supply which is just as important as the peak demand. This other aspect is the "average demand", for an hour, or a day, or a week, which is a measure of energy or quantity of electricity, as distinct from the actual demand or actual load which varies from instant to instant.

The peak load or maximum demand governs the size of generating plants and exercises a major influence upon cost. Partly because of this and partly because of the complexity of the practical operating problems involved in making the best use of both peak power and energy resources, public references to the "average demand" or to energy have been comparatively rare and the significance of this aspect of power supply is but little understood.

While reductions in the Niagara system peak demands can be effected by exercising the right to reduce deliveries to interruptible customers, the contracts stipulate that these rights can be exercised only for limited periods of short duration. It follows

that even though the demands of the interruptible customers at peak may be reduced 100 per cent, the average demand, which represents the energy delivered to them, can be reduced very little; thus the interruptible privileges do not furnish any material relief from energy demands, nor the equivalent of a substantial energy reserve.

For sudden brief losses of capacity the relief provided by suspending delivery to interruptible customers is very valuable, but where the loss of capacity extends for many hours, or days, or weeks, the interruptible privileges alone cannot provide the necessary protection. A reserve of energy is indispensable for protracted losses of supply which reduce the energy resources of the system and, while the quantitative aspect of the question of providing an adequate energy reserve cannot be discussed in this address, it is well to note that the 75,000 horsepower of "emergency reserve" to which reference has already been made, does furnish a very valuable and necessary reserve of energy.

*Utilization of Emergency Reserves*

It must not be supposed that the capacity made available as a reserve to provide against emergency loss, is allowed to remain idle awaiting the moment when emergencies require its use in whole or in part; far from it. Reserve power is put to work. That portion described as "emergency reserve" is sold on a strictly at-will basis which ensures its instant availability to supply the primary demand in case of need, for the "at-will" supply may be interrupted without notice and without limit as to time. The second line of defense to offset losses of capacity is an actual curtailment of the primary load at the time of peak demand. As already pointed out, this is accomplished through the interruption of delivery to certain customers whose contracts make specific provision for a limited interruption. As the price received for the power sold with interruptible privileges is nearly as great as for firm power, it must be quite clear that this portion of the so-called reserve is very usefully employed. Only a few special types of industries, among them those producing electrochemical and electro-metallurgical products, are able to utilize *large* blocks of either at-will or interruptible power. Considering the further restriction that it must be possible to obtain quick action in interrupting the delivery, it follows that the users of this power must be so located and so supplied as to make this possible.

*Load Growth Trends*

Having reviewed the causes of losses in capacity and interruption to supply in a large power system, and examined the reserves of power needed to cope with these contingencies when they arise, we are now confronted with the more difficult task of reaching some conclusion as to future power demands.

Prior to 1929 continuous expansion to meet growing markets was the experience in most industrial enterprises. It was reflected in the Commission's operations by continually increasing demands for power throughout the various systems. From the inception of the Commission's operations until the winter season of 1929-1930, the annual increase in primary power demand in the Niagara system aver-

aged approximately ten per cent, and in only one span of ten consecutive years during this period did the demand fail to more than double.

The depression brought this period of expansion to an abrupt end, and by the winter season of 1932-1933 the primary peak demand had receded 150,000 horsepower.

The major proportion of this recession in primary demand occurred among the very large industrial customers in the Niagara district, principally those utilizing interruptible power. The domestic load did not shrink but, if anything, continued to show some growth. Early in 1933 an upward trend was again clearly established. Since 1932, when the decreases following 1929 were halted, the annual percentage increases in primary demand in the Niagara system have been:

| Winter Season | Percent |
|---|---|
| 1933-34 | 0.6 |
| 1934-35 | 2.5 |
| 1935-36 | 2.8 |
| 1936-37 | 7.9 |
| 1937-38 | 6.3 |

and during the first ten months of 1937 the average rate of growth in primary load on the Niagara system was equivalent to a rate of 11.2 per cent per year. Although this rate was not maintained during the last two months when the so-called recession occurred, it is an indication of what may have to be faced at least for certain periods in the future.

No one can foretell the future with certainty. Our speculations concerning it must be based upon the trend or the appearance of trends established in the past. Although for many years prior to the depression, the Niagara system showed a very consistent growth in primary load, as already mentioned, a marked disruption has occurred in the interval, so that, under present conditions, it is peculiarly difficult to be confident as to just what the power demands of the future will be, especially as they depend so much upon industrial progress and other factors, many of which seem to be unusually obscure just now.

However, the existence of these difficulties does not alter the necessity of making provisions for the future some years in advance. To shrink from this responsibility and seek an escape by timidly making provision for no more load growth than now appears to be certain, does not appear to be in the best interests of the power users of the Niagara system, for while this course avoids the risk of over-provision, it incurs the risk of a power famine which, quantity for quantity, *is much more serious.* The fact must be faced that it is practically impossible to escape risk one way or the other. To do so it would be necessary to avoid either excess or deficiency and to provide just the correct amount of power, which of course, could hardly be expected when making decisions several years in advance.

In December, 1937, the primary peak, including transfers to the Georgian Bay system, was slightly over 1,135,000 horsepower; adding 75,000 horsepower for emergency reserve, the figure for a proper supply is obtained, namely 1,210,000 horsepower. Prior to the revision of the

Quebec power contracts, the system resources including the "growth reserve" of 120,000 horsepower available from the Gatineau Power Company was 1,310,000 horsepower*, so that deducting the 1,210,000 horsepower just mentioned it will be seen that the growth resources available for 1938 and thereafter amounted to 100,000 horsepower.

This question of load growth and probable future demands would require for comprehensive treatment almost as much time as is permitted for my entire address; I can only add now the conclusion reached by the Commission's staff. This is that while future load growth is most difficult to predict it would be unsafe for the Commission to make provision for a growth in primary demand of less than approximately 7 per cent. per annum; in other words, it appears that the consequences of shortages which might occur if a smaller provision were made would be more serious than the consequences of any over supply which might occur if provision at 7 per cent per annum were made. For convenient reference the latter will be termed the "probable best provision."

Using December, 1937, as a starting point, it is now a simple matter to show the additional amounts of power required from year to year, over and above the "growth resources" which were available under the Gatineau contract prior to the recent contract revisions. After allowance for emergency reserves and for transfer to the Georgian Bay and Eastern Ontario systems not required after 1937, the amounts of power required for the "probable best provision" are as follows:

| Year | Total requirements "Probable best provision" | Requirements in addition to growth resources in hand prior to contract revision |
|---|---|---|
| 1938-39 | 1,281,000 h.p. | 0 h.p. |
| 1939-40 | 1,365,000 " | 50,000 " |
| 1940-41 | 1,455,000 " | 140,000 " |
| 1941-42 | 1,552,000 " | 237,000 " |
| 1942-43 | 1,655,000 " | 340,000 " |

### COMPARISON OF RESOURCES AND REQUIREMENTS

Having indicated the relationship between probable future needs and resources as they were prior to the

*This figure increased to 1,315,000 horsepower in 1938 and following years due to expected higher level of Lake Erie and consequently increased capacity of the Queenston plant.

### HORSEPOWER CAPACITIES REQUIRED TO MEET GROWTH

| Year | Dependable capacities provided | "Probable best provision" 7% primary growth | Requirements to meet only 5% primary growth | Amount by which present provisions exceed: "Probable best provision" | Amount by which present provisions exceed: Requirements to meet only 5% primary growth |
|---|---|---|---|---|---|
| 1938-39 | 1,425,000 | 1,281,000 | 1,258,000 | 144,000 | 167,000 |
| 1939-40 | 1,485,000 | 1,365,000 | 1,317,000 | 120,000 | 168,000 |
| 1940-41 | 1,505,000 | 1,455,000 | 1,379,000 | 50,000 | 126,000 |
| 1941-42 | 1,555,000 | 1,552,000 | 1,445,000 | 3,000 | 110,000 |
| 1942-43 | 1,580,000 | 1,655,000 | 1,515,000 | —75,000 | 65,000 |

NOTE: Requirements to meet primary load growth include an allowance for emergency reserves.

Quebec power settlement, we may next compare the quantities of power which under the terms of the recent settlement the Commission is required to accept, with the quantities of power represented by what has been termed the "probable best provision." In order to facilitate this comparison, a table which will be published with this address has been prepared.

This table shows that the provisions made in the Quebec contracts settlement exceed the "probable best provision" as follows: 1938, 144,000 h.p.; 1939, 120,000 h.p.; 1940, 50,000 h.p.; 1941, 3,000 h.p.; 1942, minus 75,000 h.p.

These figures reveal the fact that the schedule of power to be taken under the terms of the settlement with the Quebec power companies does not exactly conform with the probable requirements of the Commission. As the settlement represents a compromise designed to satisfy the basic needs of both the Commission and the companies, it is not to be expected that it would reflect either the precise needs of the Commission or the desires of the Quebec companies. The Commission's resources prior to the recent revision of Quebec power contracts were sufficient to provide for its expected needs in 1938; however it was essential that the Commission be assured that substantial additional quantities of power would be available to meet its probable needs until it could obtain power from Ontario's own undeveloped resources, and it should be remembered that one very important result of this settlement is that it removes an obstacle to the development of the Commission's power sites on the Ottawa river.

For three years the supplies provided under the settlement exceed the "probable best provision", but thereafter the schedule of power deliveries may need to be increased if a period of industrial activity should occur. It must also be borne in mind that the available resources were 50,000 horsepower short of a proper provision for 1939-40. For the 7 per cent rate of growth upon which the "probable best provision" is based, the requirements by 1942 will exceed the capacity provided and for a smaller growth of 5 per cent per annum the provisions made will meet the requirements to 1943.

May I interject here a statement made in an address given on December 8th last:

> "It is only the part of common prudence to avoid onerous commitments so long as the future is not being jeopardized by doing so, but it is also the part of wisdom to complete preliminary arrangements and always have work so well in hand as to be able to meet, by acceleration of existing programs or otherwise, whatever growth in demand is reasonably probable; failure to do this may have much more serious consequences than an error in the reverse direction, especially as the cost of reserve power is comparatively little owing to the ready market for it on an at-will basis."

I think you will agree that the estimate of requirements is quite in accord with the spirit of this state-

ment and that in the circumstances, after taking into consideration the disadvantages of being compelled to embark upon a program of extensive steam development as an alternative to Quebec power, and the rights and needs of the Quebec companies which obviously had to be taken into account in any compromise settlement, the settlement itself is also in harmony with the spirit of the statement.

In this connection may I point out that irrespective of the form which future power commitments may take, corresponding financial commitments inevitably go hand in hand with them. Strangely enough there has been a tendency in some quarters to look with strong aversion upon financial commitments for future power supplies in the form of contracts to purchase, under which stipulated quantities of power must be accepted by the Commission year by year in accordance with a predetermined schedule, while offering no objection whatever to financial commitments in the form of capital expenditures upon large power developments; yet I know of no form of financial commitment more utterly irrevocable than the latter. It goes without saying that from the broad viewpoint, and other things being equal, Commission-owned hydraulic power developments in Ontario are preferable to outside purchase agreements, but when such developments cannot be made power must be secured from other sources.

### CONCLUSION

The essential facts relating to power resources and power requirements of the Niagara system have now been given and the dependence of the Niagara system upon Quebec power for its probable requirements during the next few years has been demonstrated. Only the probable consequences of refusing to make a settlement with Beauharnois which involved a revision of the contracts with Gatineau and McLaren Quebec remain to be considered.

The Beauharnois Light, Heat and Power Corporation held a judgment against the Commission, which had been confirmed by the Appellate Court of Ontario, for upwards of $7,000,000 representing the Company's claim for payments due under contract. The Court's decision also validated the power agreement between the Commission and the Company. The Commission had entered an appeal to the Privy Council against this judgment, the ultimate result of which could naturally be only a matter of conjecture on my part. I was aware that a confirmation of the adverse judgment by the Privy Council, unless circumvented by legislative action, would have made the Commission liable not only for a payment due December, 1937, of approximately $7,000,000, but also for such additional payments as would become due from time to time, under the terms of the original contract, for the full amount of 250,000 horsepower at $15 per horsepower; this would have amounted to $3,750,000 per year.

In view of Ontario's virtual dependence upon Quebec companies as the only assured source of hydraulic power, capable of supplying the growth in demand until such time as the Commission's own hydraulic resources could be developed, and in view

of the consequences of an adverse Privy Council decision, it seemed to me to be wise and prudent to seek an amicable settlement of this unfortunate dispute which would avoid the need for extensive steam power developments without imposing undue financial burdens upon the municipalities, at the same time clearing the air between Ontario and Quebec. I, for one, have been convinced that concessions on both sides were necessary, that a sympathetic effort to find a fair basis of settlement was imperative, and that nothing short of obvious unreasonableness and obduracy on the part of the Quebec companies would justify in the eyes of the public the continuance of a struggle which could be maintained only by having recourse to further legislative measures.

No negotiations with the Quebec power companies, either directly or indirectly, were undertaken by me prior to my appointment as Chairman, but immediately thereafter I considered the conduct of those negotiations to be my most important task and I am happy to say that in my opinion the agreements which are the direct outcome of them, are fair and advantageous to both parties.

While the Commission has been compelled to obligate itself to take somewhat more power than it might have desired to take during the next few years, it must be remembered that this is by no means an uncommon situation when providing for the future; in fact when developing large hydraulic power sites it is the rule rather than the exception. Moreover, it is improbable that the Quebec contracts settlement will impose any greater strain upon the Commission's resources than would have been imposed by proceeding with a large full-head development at Niagara, if that had been possible.

In view of the uncertainty as to industrial conditions, it may be that there is some justification for anxiety as to whether or not the Niagara system load will make substantial growth during the next five years. It is to provide against this eventuality that the Commission is asking for a license to export power to the United States under conditions which I consider to be in the best interests of Ontario, Quebec and Canada. As the pros and cons of this question of export have been stated by the Prime Minister of Ontario to the Minister of Trade and Commerce in a letter which has been made public and as my address is already lengthy, I shall content myself tonight with pointing out that the conditions surrounding export have altered greatly as a result of the recent appearance of very large interconnected power systems. Certain ideas which were a natural outgrowth of former conditions are no longer applicable; in the case in point there is no possibility of establishing a dependent industry in the United States; the industry is already fully established and it is not dependent; nor is there any risk of diminishing the chances of securing a branch industry in Canada because the branch industry has been operating here for years. Moreover, in my considered opinion, there will be no difficulty whatever in discontinuing the supply of power in accordance with the terms of any agreement which may be made.

In this case, if the terms which are written into the agreement to export are advantageous to Ontario and to Canada, as I believe they would be, then I feel that we should have no hesitation whatever about the matter.

While I have attempted to explain to you the circumstances which induced me to recommend to my fellow Commissioners the settlement recently effected with the Quebec power companies, I naturally am aware that there has been a very abrupt change in Commission policy. I feel also that there may be some who are concerned about the settlement, partly because it *does* represent a direct reversal of policy and partly because of the severe public pronouncements relative to the settlement, made by members of the former Commission. To those who may feel concern on this account, may I say that the basic facts regarding power supply and demand, and the conclusions relating thereto, which I have presented to you tonight, are strictly in harmony with the views and opinions that I have consistently held and expressed to the Commission which held office prior to my appointment. So far as I am aware, these same views have been universally held by the Commission's staff. The fact that the former Commission held entirely different opinions and reached totally different conclusions is something for which its members alone must accept full responsibility.

It is my opinion that the Commission's future power needs alone justify this settlement, but whether others do or do not agree with this, whether the provisions for future growth prove to be somewhat large or somewhat small, the fact remains that other interests besides the Commission's were at stake and your Commission believes that this settlement, effected in a spirit of co-operation and compromise, will make for goodwill and cordial relations between Ontario and Quebec and inure to the benefit of the two provinces and of Canada.

Permit me to express my deep regret at having been compelled to be absent tonight. It would have given me genuine satisfaction and pleasure to be with you and to have had the privilege of delivering my address in person.

*Cameron Falls generating station, Nipigon river.*

# Control Systems for Domestic Loads

By W. B. Buchanan, Testing Engineer, H.E.P.C. Laboratories

*(Presented to the Association of Municipal Electrical Utilities at Toronto, February 8, 1938.)*

ANY comprehensive treatment of the above subject from the point of view of engineering analysis involves such factors as follow:

I. Method of signalling and equipment for control.
  - First cost and space required.
  - Cost of maintenance.
  - Cost of attention, e.g., hand or automatic control.

II. Method of Transmission of control impulses.
  - Cost of channels.
  - Cost of maintenance of channels.
  - Sensitivity of channel to interference from extraneous causes, e.g., induction from power lines or earth-potentials.
  - Range of operation or distances involved.
  - Load density or controls per unit area.

III. Method of Detecting or Utilizing Signals.
  - Cost per unit of control for the type of service required.
  - Degree of selectivity or number of types of operations that may be desired.
  - Report back features by means of which an operator may be assured as to the complete and correct functioning of the apparatus.

Even a casual consideration of these factors is sufficient to indicate great difficulty in arriving at any single simple answer as to what system is the best to use. A variety of systems of terminal apparatus may be adapted to various types of channels so that while the above elements may be considered as independent in some respects it might be said that as the cost of the channel increases a larger investment in terminal apparatus can be justified if the former can be reduced.

The field of remote control with automatic report-back features has been developed to such an elaborate degree that the control of domestic loads appears to be one of the less intricate of such problems. This fact doubtless tends to make a greater variety of methods and equipment available for the latter purpose at reasonable cost.

During the period of the Convention Session of January, 1932, an informal discussion of the principles involved in this problem was held at the Laboratories and a demonstration given of relays operating from 500-cycle carrier wave superimposed on a

110-volt lighting circuit. Some advance in general practice appears to have resulted from that conference and further additions have since been made by those interested in the development of apparatus.

Probably the most convenient subdivision of the subject for the present purpose may be made by segregating the various types of channels in use or that have been proposed.

1. Interruption of one or more phases of the power supply sometimes known as "winking of circuits."
2. Interruption or opening the ground lead of a system having limited number of ground connections to its neutral. The live wires then operate in parallel to carry the control current through relays and ground connections.
3. The use of auxiliary messenger, or "pilot" wires to carry the control "impulse."
4. The introduction of a ripple or carrier wave on the power voltage wave-shape having much higher frequency than that of the power circuit. A number of such frequencies may be used giving a multiplicity of channels over the same conductors without interference.

1. Several years ago control relays were offered based on winking of the circuit as their operating feature. Such a mode of operation could hardly be expected to have any extensive application and we haven't heard of any successful installations being made in recent years. There might, however, be isolated cases where such a scheme could be used to some advantage.

2. A system introduced in the United States within the last few years under the trade-name "Polatrol" involves opening the neutral lead and introducing impulsing currents over the line conductors. A variety of operations can be performed by a code arrangement of signal impulses and where operating conditions permit this seems to offer a satisfactory scheme for controlling domestic loads.

The writer is not aware of any general ruling within this organization with respect to the adoption of the system but holds the opinion personally that considerable difficulty would be encountered in any substantial effort to incorporate it as a standard distribution practice.

A system somewhat similar has been developed and is said to be in use in France.

3. This system doubtless should be dated back to that of the telegraph since through the medium of a telegraph or telephone relay at the receiving end a great variety of operations can be carried out. A number of operations could be directed simultaneously over one pair of wires by suitable arrangements of terminal equipment such as were used in multiplex telegraphy before the introduction of carrier-waves and electronic tubes.

The remote control by pilot wire involves passing sufficient current over the said wire to operate the mechanism involved or a supply of power at the receiving end which can be utilized by means of an interposing relay.

Formerly remote controlled switches of sufficient capacity rating required a substantial amount of current for their operation. Recently, however, a switch is being supplied said to operate on 0.035 ampere at 25 cycles and capable of carrying up to 35 amperes. This low demand on operating current permits either the use of smaller sizes of wire than formerly, or greater distances of control or a greater number of relays could be operated at the same time from one pilot-wire.

No arbitrary limits are set as to the nature of the electric supply that may be used to operate such a system, either direct-current or alternating-current of any frequency may be used. For the simple purpose of reducing the peak demand on a feeder the normal line frequency at say 110 volts offers a very economical and effective source of power.

The cost of a pilot-wire channel is likely to vary between wide extremes. If pin-space on poles be already available without additional cost this part of the problem is simplified but if entirely new channels in congested districts must be negotiated the expense might readily become excessive. The low current demand, however, permits grouping of such control wires together in a cable thus conserving space if a multiplicity of channels be required.

The application of a pilot-wire system can be simplified by providing an individual feed wire through the service pipe and grouping several of these under the control of one relay at the top of the pole. The difficulty and cost of introducing either a pilot wire control or the separate feeder wire connecting to the load should not be overlooked.

Tandem control can be introduced if desired but there is an advantage in having all control current indicated at the control-station thus indicating to some extent the number of units of load affected and substituting in some measure for the "report back" requirements of more elaborate systems.

4. Carrier-wave control has been advocated for some years and by several manufacturers. Means for introducing a carrier wave superimposed on the line voltage as a ripple is required. The frequency should be substantially higher than standard system frequency to limit the cost of suitable couplings. There is a range of frequencies corresponding to those of tooth-ripples on generator wave-shapes that, in general, it is prudent to avoid because of the possibility of interference. Such considerations have resulted in the adoption of 420 to 720 cycles (below this interference range) and approximately 3,000 cycles which is well above the interference range.

Two systems of coupling to the power lines have been used,—a parallel feed by which the entire system is excited at one operation, or a series system adapted to radial distribution by means of which separate sections may be excited. The latter can be accomplished with less generator capacity but more than one group of coupling units may be required.

Transmission and control of the carrier wave depends on the electrical

characteristics of the power system and hence considerable data thereon may be required to adapt a carrier-wave method of control to any given case. The procedure, however, is fairly well defined and the dependability of such a system might be said to rest in the reliability of the sending and receiving equipment.

A number of manufacturers have supplied such equipment and no doubt would be glad to supply information re their particular apparatus.

The much greater cost per relay is a handicap in the application of this system to the control of domestic load. It should be feasible, however, and in some cases it might be economical to use a small number of carrier controlled relays for distances in excess of say a couple of miles and pilot wire distribution therefrom for sectionalizing purposes.

The possibility of operating carrier control even though a power line be grounded or otherwise unusable should probably be noted though this feature may not have any particular value in domestic load control.

A general discussion of this subject would not be complete without mention of the time-honored time-switch control. Due, however, to the difficulty of pre-selecting the correct time of operation as well as the cost it does not seem to be adapted for the control of the peak load.

Another scheme that might have some special applications locally would be to install an over-current circuit-opening relay operated from the load on a transformer bank or feeders, the relay serving to discriminate between the types of load that should have preference. This scheme may be used to improve the load factor on a given feeder but whether it would improve the system load factor or not would depend on the time of occurrence of the peaks on the load curves.

*Approach to Queenston generating station.*

# Insulated Cables for Power Distribution and Street Lighting Circuits

By O. W. Titus, Chief Electrical Engineer, Canada Wire and Cable Company, Ltd.

*(Presented to the Association of Municipal Electrical Utilities at Toronto, February 9, 1938)*

THIS paper discusses the principal types of insulated cables available to the electrical utility for distribution purposes and for street lighting circuits. Mainly, these are for underground installation, but not infrequently are utilized above ground in buildings or even overhead out of doors.

It is intended to deal mainly with designs of long proven merit touching briefly on newer constructions which may offer some promise of economical employment in certain circumstances. Voltages up to 15,000 volts only will be considered, it being felt that most of the present audience will not be particularly interested in higher voltage cables, where specialized considerations, not of great moment in the lower voltages, would require a disproportionate time to describe, even briefly. In Ontario, within urban areas most commonly, power is taken from sub-station to local transformer at 2,200 to 5,000 volts, thence at 110-220 or 550 volts. As the 12,000 to 15,000-volt volt range is likely to be used for distribution purposes in certain cases, and in any case, is in quite common use by the local utilities in substations and between substations, it appears proper to include it in our present discussion.

Roughly, therefore, we will consider *voltage classification* as follows:

(a) Up to 600 volts.

(b) 2,200 to 4,600 volts.

(c) 10,000 to 15,000 volts.

It is understood, of course, that cables are available for all intermediate potentials.

Bearing in mind these voltage classifications, this paper discusses cable materials, more particularly insulations, sheaths and protective materials, touches briefly on duct structures, recapitulates the main types of cables and their applications and concludes with an easy method of determining current-carrying capacities and conductor sizes illustrated by numerical examples. The graphs and their adjustment factors are sufficiently accurate for most practical purposes. In the interest of simplification, only average conditions are dealt with; consequently, if the installation is large and conditions depart markedly from those assumed, the problem should be referred to a

competent cable engineer, together with full particulars.

## CABLE MATERIALS

### A.—CONDUCTOR

Annealed copper is almost universally employed as the conductor, although for self-supporting cables, hard-drawn copper or even an alloy or copperweld may be employed when a small current is involved and conductivity is not as important as strength.

The principal characteristics of annealed copper are well known and tables of resistance, strength, dimensions, weights, etc., are in the possession of practically everyone.

### B.—INSULATION

It should be borne in mind that cable insulation has a much more difficult role than most other insulations. In other apparatus, the insulation usually is held rigidly, so that it is subjected to very little mechanical working after being applied. In the case of cable, however, the insulation must be capable of being bent, sometimes repeatedly, and at the same time subjected to crushing and other stresses incidental to being pulled in in long lengths in ducts and to repeated bending in service from expansion and contraction with load fluctuations.

A further consideration to be borne in mind is that the insulation should have not too great a resistance to the flow of heat, since the copper losses must be dissipated through the insulation sufficiently readily to prevent the temperature rising above limits which might cause deterioration of the insulation.

The chief enemies of insulation, to which insulation must be resistant, or against which insulation must be protected are:

(a) Moisture.

(b) Air, especially the oxygen content.

(c) Ionization of gas pockets or voids in the insulation or filler spaces —only becomes a factor in the higher voltages, above about 5,000 volts for rubber and above about 7,500 volts for paper and varnished cloth.

(d) Corona at the inner or outer surface of the insulation. This is essentially a special condition of ionization. It makes the use of rubber questionable above 5,000 volts, although, where the conditions are such as to demand the use of a rubber type of insulation, certain "Corona-resisting" rubbers, such as Gencorone, Kerite, etc., are available. It is usually best, however, to employ varnished cloth or paper when in the voltage range where corona may be formed.

The range of insulating materials available is tremendous. Specialized requirements have developed an amazing variety of these, each with its peculiar merits and weaknesses. They are much too numerous to even attempt to list in a paper of this type. Fortunately, the three principal insulations are still the overwhelming favourites and due to their electrical and mechanical strengths, their reasonable cost, their workability, their long life, and their adaptability to use as a cable insulation, they are likely

to remain so for some time. These are :

1. Rubber.
2. Varnished Cloth.
3. Impregnated Paper.

So far as actual electrical strength is concerned, all three types of insulation have very great factors of safety.

For example, at 15,000 volts, the average working stress on impregnated paper would be approximately 60 volts per mil. The dielectric strength at working frequency would be over 500 volts per mil. Under surge conditions, due to lightning, the strength of impregnated paper is in the order of 2,000 volts per mil, i.e., ¼ in. of impregnated paper would stand about 500,000 volts.

### *B.1.—Rubber Insulation*

It is not intended to go into the subject of rubber chemistry — certainly one of the most complicated in the whole industry. We will deal only with the final compounds.

From a cable viewpoint, we may divide rubber compounds into:

(a) Insulating Compounds.

(b) Protective Jacket Compounds.

### *B.1.(a).—Insulating Rubber Compounds*

(1) So-called *"Code Grade" Compounds*. These, from our viewpoint to-day, may be regarded as the minimum quality. They have, however, a remarkable record of excellent service in housewiring and for general purposes. Requirements are specified by C.E.S.A. and enforced by rigid inspection and test by the H.E.P.C. Approvals laboratories, when employed in "labelled" wires and cables.

(2) So-called *"30 per cent. Grade" Compounds*. These have a minimum content of 30 per cent., by weight, of new Hevea rubber. They are stronger, more elastic, more abrasion resistant and in every way better than Code. As the "Performance Compounds" are supplanting these, we will not deal further with "30 per cent. Grade" compounds.

(3) *"Performance" Compounds*. In these, no rubber content is specified, but the compound is judged by the tests which it will pass. These are the modern outgrowth of the "30 per cent." specifications eliminating chemical tests and permitting the employment of modern developments in accelerators and anti-oxidants. These are the super-aging compounds resistant to oxidation, and are recommended wherever a high quality, long-lifed installation is required. Usually their use involves only a few per cent. increased cost in the cable and, of course, the life of the insulation is the life of the cable.

(4) *"Special" Compounds* for special purposes such as heat-resisting, corona-resisting, submarine, purified rubbers, etc. We will not go into the subject here.

### *B.1.(b) Protective Rubber Compounds*

These compounds are designed for mechanical strength and abrasion resistance and are similar to tire stocks. Their insulating qualities are relatively poor. They do not fall under the range of the present paper.

Below are tabulated the principal characteristics of the two main rubber insulating compounds used in cables:—

| | Code Rubber | Performance Rubber |
|---|---|---|
| Tensile Strength, Minimum, Lbs./Sq. In. | 500 | 1200 |
| Elongation at Rupture, Min. per cent | 150-200 | 400 |
| Maximum Depreciation after Geer Oven Test in Tensile Strength | 40% | 15% |
| Maximum Depreciation after Geer Oven Test in Elongation | 25% | 15% |
| Specification | C.E.S.A. C22. 2 No. 38 | A.S.T.M. D353-36T. |

Note. (a): In the Geer Oven Ageing Test, specimens are heated in an oven in air at 158 degs. Fahr. for 48 hours for Code Rubber, 96 hours for Performance Rubber.

Note. (b): Code Rubber values, after Geer Oven Ageing Test are representative values, but not specification requirements. They are shown here for comparison.

Rubber Insulation may be summarized from the viewpoint of application in service as follows:

Highly resistant to moisture.

Very flexible.

Sensitive to corona and ionization at high voltages.

Subject to slow oxidation if conditions are bad.

Most "fool-proof" of insulations at low voltages.

Usually most costly in terms of dollars per ampere per thousand feet where relatively heavy currents are involved.

*B.2. Varnished Cloth Insulation*

Varnished Cloth (hereafter referred to as V.C.) is a cotton fabric coated with specialized varnishes designed to be flexible and highly resistant to oxidation and the entrance of moisture.

It comes to the cable manufacturer in tape forms; for cable insulating black and from 0.005 inch to 0.014 inch in thickness, straight cut (as distinguished from bias cut with which electricians are familiar for jointing purposes).

The V.C. tape is applied from pads by taping machines helically over the conductors so as to provide a maximum barrier to electric creepage and to the entrance of moisture.

V.C. Insulated Cables usually offer important economies over rubber due to the higher temperatures at which they may be operated. Their summary from our viewpoint would be:—

More resistant to moisture than impregnated paper, but less so than rubber.

Reasonably flexible.

Resistant to corona and ionization (although less so than impregnated paper).

Owing to its laminated structure, any small foreign matter in the insulation is localized and unlikely to cause trouble.

Intermediate in cost between rubber and paper.

More foolproof than the latter, but less so than the former.

Canadian Engineering Standards Association Specifications are in course of preparation but not yet issued for V.C. Insulated Cables. They follow in general the I.P.C.E.A. Specifications in the United States.

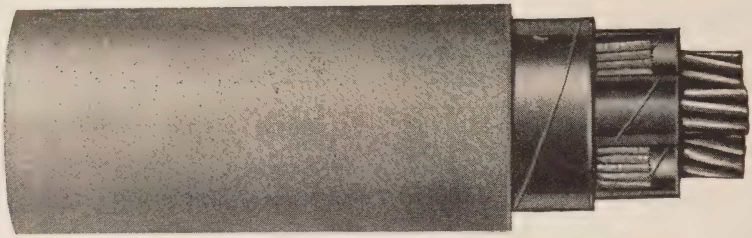


*Fig. 1—V.C. insulated lead-covered cable.*

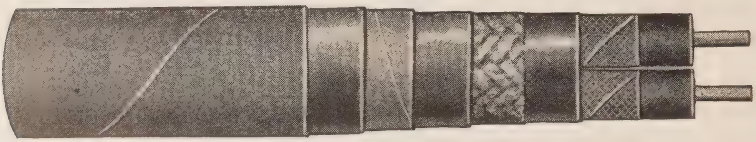


*Fig. 2—Trenchlay non-metallic sheath underground cable.*

*B.3. Impregnated Paper*

The principal insulation for power cables is impregnated paper. It, with varying types of impregnants, is used from the lowest voltage up to the very highest (a 220,000-volt cable being now in service in Paris, France).

The principal types of paper, namely, sulphate process wood pulp and manilla have been used for years, the former now being the favourite.

The copper conductors of multiple-conductor paper insulated cables, in other than the smallest size, usually are shaped so as to fit together with a minimum of waste filler space and hence to reduce the diameter and amount of lead covering necessary. See Fig. 3. For two-conductor cables, this is roughly a "D", for three-conductor an approximate 120 deg. segment of a circle and for four-conductor, an approximate 90 deg. segment.

Impregnated paper insulation may be summarized somewhat as follows:—

Applicable to all voltages.

Highly resistant to corona and ionization.

Vulnerable to moisture.

Reasonably flexible.

Low cost.

Requires reasonable care in installation and use of proper potheads, but need cause no fear if care is taken.

C. PROTECTIVE COVERINGS

Let us now consider why and how we should protect our insulated conductors. Chiefly, we must provide for:—

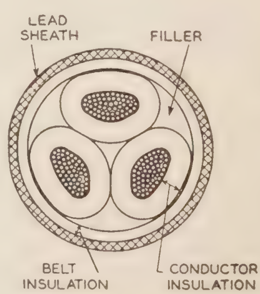



*Fig. 3—Paper insulated lead-covered cable.*

Underground—Water, Moist Air, Mechanical Damage, and sometimes dilute acids or alkalies.

Above Ground, Outdoor—Rain, Ice, Sunlight, Air, Mechanical Damage, Excessive Tension.

Indoor—Moist Air, Water of Condensation, and Mechanical Damage.

It will be seen that we must provide (a) something impervious which will seal our cable against penetrating agencies such as water and air and prevent the loss of any fluid or semi-fluid elements of the cable itself; and, (b) something which will provide mechanical protection. It would be desirable if both could be combined in one, but generally, this cannot be done especially if all conditions are severe. Complete and permanent protection is imperative.

Sealing and protective agencies are usually combinations of the following:—

C.1. Lead.

C.2. Plastic Compounds usually of Asphaltic Base.

C.3. Cotton or Jute Braids, or Wraps, Cotton Tapes, Rubber Faced or Coated Tapes, Saturated Heavy Duck Tapes.

C.4. Asbestos Braids and Fibre.

C.5. Flat Steel Tape.

C.6. Steel Wires.

C.7. Interlocking Galvanized Steel Tapes.

C.8. Ducts.

The combining of these protective elements with our three insulations has resulted in a tremendous variety of cable types, doubtless even more confusing to the user than to cable manufacturers.

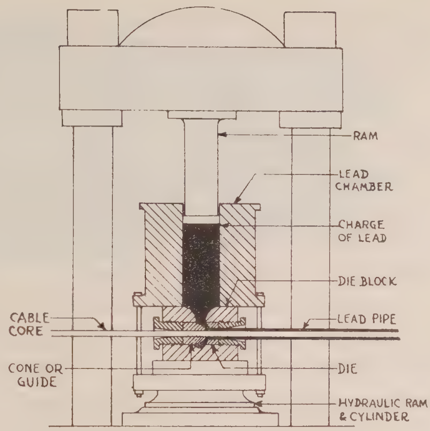



*Fig. 4—Diagrammatic section of a lead extrusion press.*

C.1. *Virgin lead or alloys of lead* have proven the most suitable sealing sheath over many years of service. Alloys of lead, usually 1 per cent antimony, or 3 per cent tin, are employed for special locations such as where vibration is anticipated (as for installation overhead on messenger wire where swaying might occur). There is a large variety of lead alloys which we will not discuss in this paper, since practically all ordinary power cable employs a sheath of pure lead. Fig. 4 illustrates diagrammatically the process employed in applying a lead sheath to a cable core.

Lead may be summarized somewhat as follows:—

Highly impervious.

Very inert chemically; hence permanent.

Readily procurable in very pure form.

Low in cost.

Easily worked.

Can be jointed readily by solder wipes to form an absolutely tight and permanent union.

Rather low yield point — about 200 lb. per sq. in. fibre stress when stressed over a long time.

Susceptible to mechanical damage unless protected.

Will crack if flexed too much or subjected to severe vibration. However, will stand all bending required for installation of permanent cables.

Specification—A.S.T.M. B.29-35.

Electrical Resistivity—6.015 ohms per circular mil foot.

C.2. *Plastics of Asphaltic Base* are very inert chemically, insoluble in water, and if sufficiently hot, highly penetrative of fibrous structures such as cottons and jutes. When properly chosen, they have the property of adhering very closely to clean metals or other surfaces, a very useful property when we wish to protect such surfaces from moisture and chemicals. Their high penetrative power at elevated temperatures and chemical stability make them the braid impregnants and preservatives by far most commonly used. Their chief weaknesses are that at a sufficiently low temperature, they become brittle while at ordinary temperatures, being plastic, they will flow if given sufficient time and if not held in place. They cannot be considered as a mechanical protection although their adhesion makes them a highly useful protection from air and moisture within reasonable limits. They differ one from another quite widely.

*C.3. Tapes*

*Cotton Tapes* commonly are about .010 to .012 inches thick with a low grade preservative compound callendered into one or both sides. Commonly used as a covering immediately over rubber insulation or as a binder over two or more conductors and their fillers when cabled together. These so-called *"rubber-faced"* tapes are not water-tight but an extension of this idea has proven highly useful in securing water tightness for service entrance cables; namely, the use of the *"skim rubber tape"* which is a similar tape but with a substantial thickness of a plastic compound on each side which, after taping, unites with the compound of the underlying convolution of the tape to form a relatively water-tight mass. These tapes are about twice as thick as the common rubber-faced tape.

A *heavy duck tape* presaturated in a preservative compound is very useful in providing a hard, wear-resisting outer covering for non-metallic sheathed underground cables.

*C.3. Cotton and Jute*

*Cotton and Jute Braids* are familiar constructions to all electrical men. They are common and highly satisfactory coverings for rubber and varnished cambric insulation for dry locations. They are used below ground to a limited extent where first cost is of more importance than permanence. Their function below ground, or in wet locations is really as a carrier or framework for the asphaltic impregnant. The cotton or jute braid, being an organic material, usually will leach out in the course of years if in wet location, but leaves the protective asphaltic coating in place besides serving to protect the insulation while being installed. Braids normally run from .016 inch to .056 inch in thickness depending on the size of cable and service intended, cotton sizes

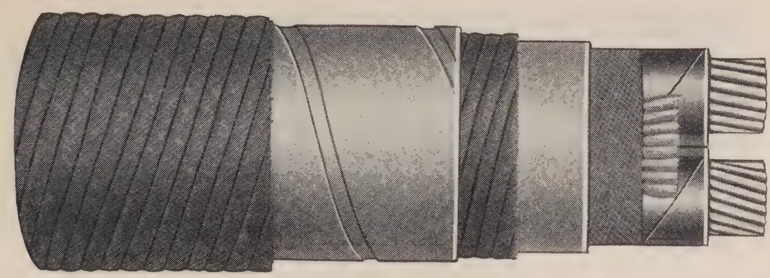


*Fig. 5—D.S.T.A. Parkway cable.*

being from two-ply-thirties to two-ply-threes. Specifications commonly used are C.E.S.A. Spec. C22.2 No. 38 and A.S.T.M. Spec. D27-36T.

*Jute Rovings* saturated in preservative compounds and heavily covered with asphaltic plastics and wrapped (not braided) with a relatively short lay are useful as beddings between steel armour coverings and lead sheaths, and over steel armour to act as a framework or carrier for asphaltic plastic coatings, the main function of which is to protect the armour from rust. The wrapping process is faster and cheaper than braiding.

*Asbestos Braids* are expensive but being mineral, do not deteriorate or leach out in the earth and give long years of service under conditions which will destroy organic braids. Their high cost, however, has militated against their use.

*Asbestos Fibre* serves a very useful purpose as a body or binder for asphaltic plastics employed as a sheathing for underground cables such as Trenchlay and Modified Trenchlay. This combination of plastic and asbestos fibre is known as "Asbestos Base Caulk."

C.5. *Flat Steel Tape.* The best mechanical protection for cables buried directly in the ground (i.e. not protected by ducts) has been proven by long years of service all over the world to be two flat steel tapes, each .020 inch or .030 inch thick by from ⅝ inch to 3 inch wide depending on cable diameter, applied open helix with the outer tape breaking joint with the inner. The tapes usually are not galvanized for underground use, but are liberally covered with an asphalt plastic and have underlying and overlying jute wraps as described above. Such cables are commonly known as "Double Steel Tape Armoured" or abbreviated to "D.S.T.A." See Fig. 5.

For use in mill or factory building a very useful and economical variant of this construction known as "*Industrial Cable*" has been developed. This uses galvanized steel tapes and omits the outer jute which, for that service, is unsightly and a favourite diet for rats and mice. See Fig. 6.

C.6. *Galvanized Steel Wires* (No. 16 NBS to No. 6 NBS) over a saturated jute bedding is the best construction where a cable is to be subjected to heavy tensions, as in submarine or mine shaft service. Usually from 15 to 36 or more wires are laid up over the cable, with an angle of about 20 degs. to 40 degs. between the axis of the cable and the armour wire.

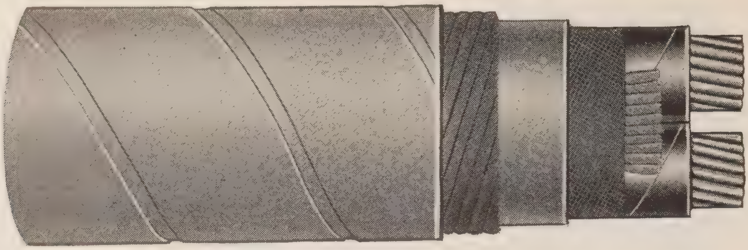


*Fig. 6—D.S.T.A. Industrial cable.*

C.7. *Interlocking Galvanized Steel Tape* has proven very useful, particularly in the smaller sizes for above ground use. This is the same armour as on Type AC cables and is familiar to all electrical men. It is relatively costly in the larger sizes.

*(To be continued)*

# Coloured Motor-Car Headlights

MOST engineers, we suppose, could quote from their own experience examples of the persistence of an erroneous idea the fallacy of which has been proved to the satisfaction of a few long before it has been generally admitted. A further example is afforded by the use of yellow headlights for motor cars, which thousands of motorists and some important transport organizations believe to have distinct advantages in comparison with a white light of the same power for driving at night or in a fog. This may be due to some effect of mass psychology which suggests that what so many believe must be true, or to an aesthetic preference to the colour, but that the advantages are either non-existent or negligibly small, appears to have been proved beyond question. For example, a resolution passed at a meeting of the International Commission on Illumination in 1935 was as follows: "Experiments carried out in different countries have confirmed that no advantage is to be obtained by the use of coloured light for driving in fog." This resolution and this country's contribution to the investigations on which it was based, were referred to in a paper read by Dr. W. S. Stiles before Section G of the British Association at the Blackpool Meeting in 1936.

Our reason for referring again to this matter is that a report on the subject has just been issued by the Illumination Research Committee of the Department of Scientific and Industrial Research, of which Committee Dr. C. C. Paterson is chairman. In drawing up this report the Committee have considered the evidence

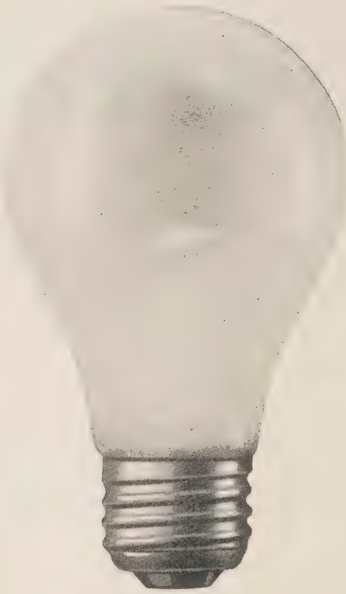
provided by numerous British and foreign investigators, both for and against the various advantages claimed for the use of headlights emitting coloured lights. The practical issues are put in the form of four questions, each of which is discussed in a separate section of the report. The questions are as follows:—(1) Can the driver of a car at night see better if he uses headlights emitting coloured light; (2) is the disturbance of a driver's vision by the headlights of other cars reduced if they use coloured lights; (3) can a driver see objects at a greater distance in mist or fog if he uses headlights emitting coloured lights; and (4) can the occurrence of coloured objects and backgrounds be turned to advantage by using headlights emitting coloured lights?

These questions are all answered in the negative although in some cases there is a slight qualification.

Since we may assume that the extensive use of coloured headlights by motorists arises mainly from the belief that they are of assistance when driving in a fog, the Committee's conclusions regarding the third question are of particular interest and importance. One of these conclusions is quite definite "that in conditions of slight or thick fog the range of visibility of objects seen in the beam of the headlight is not increased by the use of coloured light obtained from the original white light by means of a filter". One investigator, it is pointed out, finds that in clear weather the range of visibility of an object is increased by about 6 percent by the use of a yellow filter, but it should be explained that this increase was obtained at distances of the order of 900 ft. At the shorter distances at which a driver usually requires to see objects, the small advantage of the yellow filter is reduced.

With regard to the fourth question, it has been suggested that yellow and green tints predominate in country districts, and consequently brightness contrasts would be accentuated by the use of yellow light. Moreover, the visibility of the pattern in the background itself would not be improved by the use of a filter of the same colour as the background.

References are given in the report to the actual investigations on which the Committee's conclusions are based, and it appears hardly necessary to adduce any further evidence that yellow filters fitted into motor-car headlights offer no advantage to the motorist. Sooner or later their use will doubtless be abandoned in this country, unless the psychological or aesthetic factors previously mentioned are sufficiently strong to counteract the scientific facts. These factors may be even stronger in France, where at present the use of headlights emitting yellow light is compulsory.—*Engineering*.



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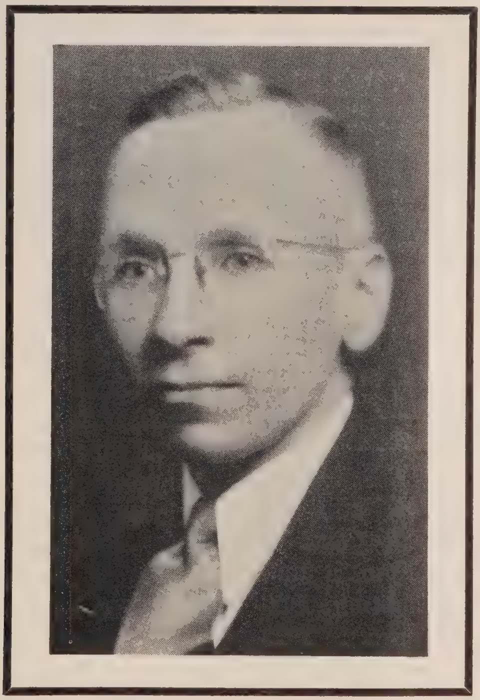

## W. B. Munro

WILLIAM BROWN MUNRO of the staff of the Municipal Accounting Department of the Hydro-Electric Power Commission of Ontario died in the Toronto Western Hospital on February 19, 1938, as the result of an operation for an ailment from which he had suffered for some time.

Mr. Munro was born June 26, 1891, in Glasgow, Scotland, and received his

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**Vol. XXV No. 3**
**March, 1938**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

education in the Public and High Schools there. He was also a graduate of the Grove Street Institute of Higher Accounting.

He was first employed by Hugh Baird and Sons of Glasgow, and in 1911 came to Canada and took a position with the Canada Malting Company at Winnipeg, Manitoba. In 1913 he came to Toronto and was in the employ of the T. Eaton Company and the Art Metropole. He was office manager of the latter concern until he enlisted for service overseas. Upon his return to Toronto, he held the position of office manager for Ryrie Brothers Limited until the Spring of 1923, at which time he took a position with the Bancroft Mines Syndicate. He joined the staff of the Hydro-Electric Power Commission of Ontario in October, 1924, and held this position until his death.

The funeral was held from St. Aidan's Church on the afternoon of Tuesday, February 22, 1938, and was largely attended.

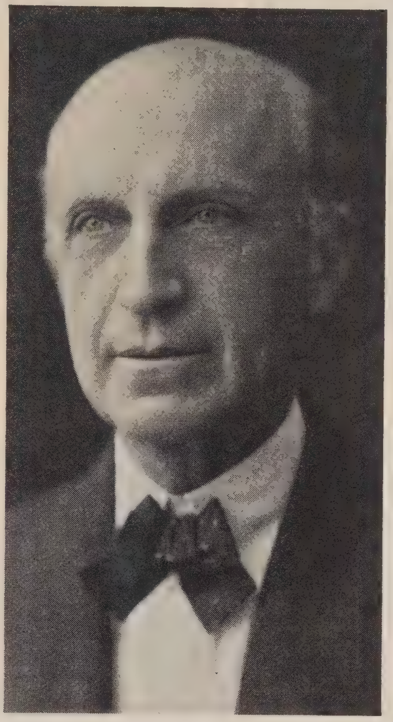
"Bill" Munro was well known throughout the Province, particularly in the Niagara System and was elected Treasurer of the A.M.E.U. for the year 1936. He was especially skilled in systematizing and a number of the Hydro billing installations in the western part of the province were put into operation under his supervision.

He will be missed by a large circle of friends and associates, and is survived by his widow and one daughter, Margaret.—*R. M. B.*

## T. W. Duggan, Brampton

On Monday, March 21, 1938, Thomas Wright Duggan, Chairman of the Hydro-Electric Commission of Brampton until his retirement last December, passed away in his 80th year. He had been in rapidly failing health since the first of the year, and his end was hastened by a severe attack of pneumonia on the preceding Saturday. The announcement of his death was received with deep regret by his many business associates in Ontario and across the Dominion as well as throughout the town and district.

Mr. Duggan was born at Churchville, Peel County, on August 24, 1858, his father being one of the pioneer merchants and grain dealers in



*T. W. Duggan.*

the county. In 1866 the family moved to Brampton where he entered the high school at the age of ten years. At the age of 14 he went to work in a grocery store and in 1879 became deputy sheriff which position he held till 1895. Early in that year he became associated with Harry Dale in the flower business as business manager. When Mr. Dale died in 1900, Mr. Duggan took complete charge as managing executor. In 1915 he became general manager, which position he held until his retirement from active work in 1933. Until the time of his death he remained a director in an advisory capacity of the Dale Estate, one of the largest establishments of its kind in the world.

In December, 1910, the town of Brampton voted to contract with the Hydro-Electric Power Commission of Ontario for a supply of power, and in August, 1911, Brampton Hydro commenced operation. The business was first carried out by the Hydro-Electric Committee of the Council, Mr. Duggan being Mayor in 1912. The Hydro-Electric Commission of Brampton held its first meeting in January, 1913, the commissioners being Mayor B. F. Justin, J. S. Beck and T. W. Duggan. Since that time Mr. Duggan served continuously on the Brampton Commission, being chairman for the past 24 years. During that time he contributed much to the success of the Brampton system and made it one of the most successful systems in Ontario.

Mr. Duggan was made a director of the Canadian National Exhibition in 1928, and served on its executive from 1933 until 1937. Last year he was made an honorary life director of the C.N.E.

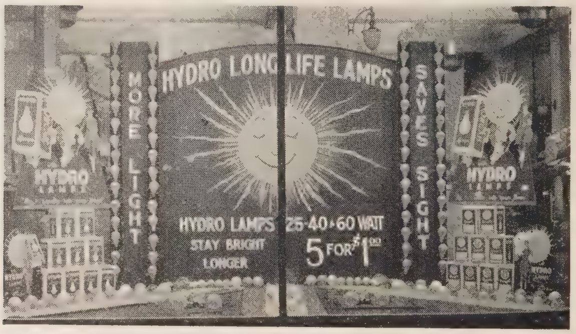
He is survived by his widow, three sons and three daughters.

# Hydro Lamp Window Dressing Contest Awards

## Class 3

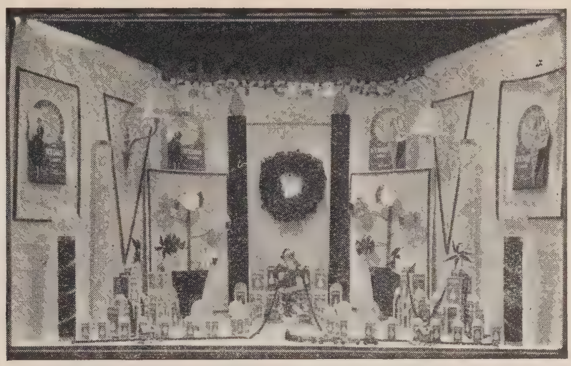
Class 3 awards in the 1937 Annual Hydro Lamp Window Dressing Contest shown herewith represent the efforts of those Hydro Shops located in the smaller cities and towns.

The selling values of these displays are very evident and the Hydro Shop staff members in this group enjoy this annual opportunity of creating displays for Hydro Long Life Lamps.

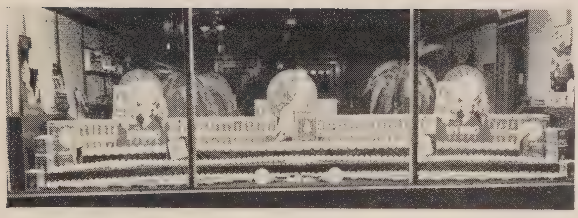



*Tie First Prize, Class 3, Stratford Public Utility Commission.*

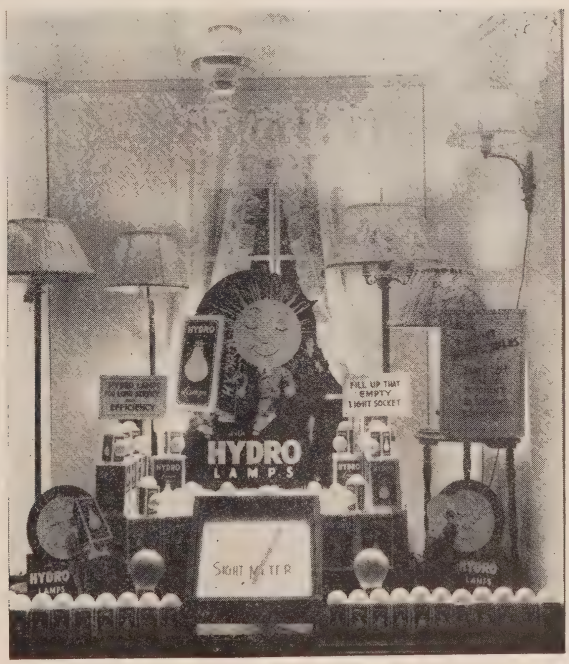

*Tie First Prize, Class 3, Ingersoll Public Utilities Commission.*



*Tie Second Prize, Class 3, Woodstock Public Utilities Commission.*



*Tie Second Prize, Class 3, Picton Public Utilities.*




*Right—Third Prize, Class 3, Sarnia Hydro-Electric Commission.*

# Convention Questionnaire

1. What is the minimum load in kilowatts in an underground distribution system 1,000 feet long that would be economical to install a net work for both lighting and power off the same secondaries?

*Mr. C. E. Schwenger, Toronto:* This question to me isn't quite clear. It does not say directly whether the 1,000 feet of distribution system is the limit of the system in mind or whether it is just the unit to be used. If it is limited to 1,000 feet, I would say from my experience that the minimum load that would be economical to put in the net work system would be about 500 to 530 kilowatts. That is actual demand on the net work. If it were part of a large system such as down-town Toronto, it would be down as low as 130 kw. for 1,000 feet.

* * * *

2. What would be the approximate cost per lineal foot for an eight-duct run laid in sidewalk area for

A—Vitrified Duct

B—Fibre Duct

*Mr. C. E. Schwenger, Toronto:* The 8 duct conduit in the sidewalk will be very little different whether it is vitrified clay or fibre. The fibre is a little more expensive in the initial cost in purchasing but costs less to lay. It will cost about $7.00 a running foot for eight-duct, including service boxes, because this will be in sidewalks, and includes the repaving of sidewalk where it has been broken.

* * * *

3. To pick up the services on the opposite side of the street would it be considered good practice to install the secondary in conduit from basement to basement? If not what are the objections?

*Mr. A. W. Bradt, Hamilton:* The Hamilton Hydro-Electric System have approximately 600 of this type of service and are definitely not in favor of them for the following reasons:

1. As these secondaries are on the customer's property, they are accessible for connection ahead of the meter. We have had several instances of energy theft due to this.

2. You are obligated to move your equipment when a building is torn down or altered, thus inconveniencing all other customers on the same supply and increasing the costs to the system over an individual service entrance.

3. Cellars are dirty, the equipment is concealed and permission has to be obtained to enter the basement. This results in a tendency to poor inspection and repairs are hampered. For instance, in case of a defect on the cable in a certain basement, the building may be vacant, the janitor may be out or at night this particular store may close early and you cannot obtain entrance until the next morning.

For these reasons, we prefer aerial rear-of-block construction. This also has the advantage of being more economical and of serving two streets instead of one as in the basement service plan.

4. What success are utility engineers experiencing in balancing transformer loads on three-wire secondary?

*Mr. J. E. B. Phelps, Sarnia:* It says here, what success are utility engineers experiencing in balancing transformer loads on three-wire secondary? I don't think they are having any success. I think it is a question that we have with us everlastingly. We have no solution. We will always be trying to get this balance. It is a consummation devoutly to be wished for, but I don't think ever attained, on any system.

On our system we have a card for each transformer and on this card we designate the two live wires as the top wire and the bottom wire. When we get a service to run, the Superintendent looks up his card, finds how many services he has got on each one of those wires, with the idea of trying to keep the same number of two-wire services equalized. And then, possibly, you might imagine when you get a three-wire service that you have got a balance and there again you are crazy. You don't get it because you may get a lot of electric ranges hooked up on a three-wire secondary, and you may find out that the electrician who coupled them up has all the hot plates on one live wire and the ovens on the other wire. The hot plates are used most frequently by the housewife and consequently a three-wire service doesn't give you a balance.

Then, you go out with your ammeter, try and get some record of the actual demand, probably with the demand ammeters, and you switch around some load to try and suit the information you get. You only do it for that one condition and when some other condition comes on, you are all hay-wire again.

So, as I say, it is something that you have got to work at continually. When you haven't got anything else for your linemen to do, it is a darned good job to put them at.

I don't know if anybody else can give us information that will tell us how more accurately we can get this balance, but if you have any information, I would be very pleased to hear it and have it passed along.

*Mr. J. W. Peart, St. Thomas:* I happened to be out of the room when Mr. Phelps told of his experience in regard to the balancing of loads on secondary feeders. I can only, therefore, relate some of our experiences in St. Thomas in reference to the subject.

This question of unbalanced secondary feeders is the perennial bogey that faces all Distribution Superintendents and, at this late date, I am rather doubtful whether we can adopt any drastic changes to permanently eliminate the problem. Doubtless we will always have unbalanced loading to contend with so long as we continue to operate 220/110 volt, three-wire secondaries and our consumers continue to install or use 110-volt appliances.

Some municipalities incur an appreciable expense in searching for and correcting this unbalanced load condition. We used to spend quite a lot of time in placing split core cur-

rent transformers and graphic ammeters on the secondary bus for periods of from one to three days. Lately we have found that we obtain a fairly good indication of load conditions on such feeders by simply placing two single-phase graphic recording voltmeters on the three-wire service farthest from the transformer. When unusually low voltage is observed on one meter while high voltage prevails on the second meter, it is apparent that the reduced voltage is the result of an excess load on that side of the bus.

When it is found necessary to equalize the load on the bus, our attention is first given to the two-wire services. These are checked to see that there is an equal number connected to each side. It is often found that such procedure is not sufficient to correct the trouble and it is then necessary to reverse three-wire range services. Special attention is required in regard to the presence of flat-rate water-heaters.

It is my opinion that the job of balancing secondary loads can only be accomplished by the "trial and error" method. It is, of course, quite impossible to maintain a balanced condition at all times. The greatest success we can hope to attain is to obtain an approximate balance at those times when the maximum load is being carried on the feeder.

While I have suggested that graphic voltmeters serve very well in studying secondary loads, there are at infrequent intervals cases where abnormally low or high voltages on opposite sides of the bus are not the result of unbalance. Only recently we had occasion to investigate a condition where the housewife found that the kitchen lamp increased greatly in brilliancy when she turned on her high wattage element. On the other hand, when she happened to turn on her next favorite element, the kitchen lamps dimmed considerably. After considerable investigating, a loose terminal connection on the neutral jumper in the service box was discovered. This had been caused by the flat copper strap actually having a slightly concave surface so as to reduce the current carrying capacity of the neutral lead. Over a period of time, heating had occurred to such an extent as to pit the surface and cause a high resistance. The condition was remedied by simply filing the surface of the strap so as to afford a perfectly flat surface.

Possibly these remarks may be of some value; in my opinion, the task of maintaining a reasonable balance on secondary feeders is one that requires continuous attention on the part of the Line Superintendent or that employee who is held responsible for the maintenance of good service. Testing must be carried out at frequent intervals with the object of maintaining that balanced condition that will afford minimum current and maximum voltage.

*Mr. H. R. Hatcher, Galt:* I have just two or three words to say. I quite agree with Mr. Phelps that this is a bogey, a perennial one, and must be taken care of continuously. We are using a two-element ammeter-volt-

meter for making tests of both sides of three-wire services to find where unbalance is. We are trying to balance loads with hot water heaters by shifting from one side to the other and we are meeting with a certain amount of success. No doubt it is a bogey and must be gone after until such time as ranges and those other appliances are 220 volts and we can then get them on the 220-volt leads.

* * * *

5. A secondary feeder supplying lighting and small refrigeration load —the voltage fluctuates considerable due to the starting of these motors, which are up to 5 horsepower in size. What is the remedy?

*Mr. D. E. Charters, Windsor:* The expensive way to correct this flicker complaint would be to increase the size of secondaries and possibly relocate the transformer.

Flicker depending on the individual eye may be objectional from say 1½ to 3 volts, depending also on frequency. This drop in voltage is caused by the additive drops in voltage from wiring within premises; service entrance wiring — service drop wires; the utilities secondary wiring from consumer to transformer; drop in transformer and finally primary drop. If we allow a percentage drop to the service pole of say 3 per cent., and if we eliminate the primary drop, the drop in transformer regulation, plus secondary drop must be about 3 per cent. and if transformer is fixed, the remainder must be taken up in the secondaries. Suppose the motor in question was 500 feet from the transformer. The voltage drop would vary as the impedance of the line, as the resistance is the largest factor in order to cut down the voltage drop 100 per cent. we would be compelled to use a wire of half the resistance. This means replacing the present wire with wire of double the capacity. Conditions arise where moving of transformer closer to load would be justified. It might be advisable to string separate small power secondaries or even hang a separate transformer.

We might look on this flicker as a disease and we should first start and cure the cause of this disease. I mean we should have our customers obtain proper motor specifications, including voltage rating. We should insist on motors wired for 230 volts or for small fractional h.p. motors wired 115/230 volts and if flicker is objectional on 115 volts, rewire for 230 volts. The customer must supply proper size wiring in building. Oftentimes special starting equipment, including motor and refrigerator pump should be provided. If customer would consult Engineering Department and advise size of motor, etc., required, the Engineering Department should be able to foresee and forestall this complaint. Transformers are more or less permanently located, thus leaving only increase of secondaries available or separate secondaries necessary. If flicker is caused from load directly off transformer, it may be necessary to increase not only transformer, but also primaries. This motor condition is one of the main reasons for

interconnecting adjacent secondaries and the more recent networks of to-day. The pros and cons of this are well known by all and lead us into another large field of engineering.

Small fractional h.p. motors operating on 115 volts where motors cannot be connected 230 volts and are cause of light flicker has been solved by some engineers by installing a suitable auto transformer in the three-wire Edison lighting secondaries at the consumer's pole or premises and has the effect of reducing voltage drop by 100 per cent. The auto transformer can be installed without any line re-arrangement or interruption to service. Secondary systems which give satisfactory service for conditions of steady load and are even of sufficient capacity to provide for several years' load growth, are inadequate if voltage changes caused by motor starting are not sufficiently limited to prevent the occurrence of objectionable flicker.

Thus the distribution engineer is faced with the problem of adequately adapting secondaries to meet this requirement as economically as possible. A customer complaining of flicker caused by his own equipment, which is not affecting his neighbors should take care of the condition.

Thanks to our manufacturers of to-day, modern motors and equipment with ball bearings, etc., are aiding in no small way.

*Mr. P. B. Yates, St. Catharines:* This is a question which is not often encountered in the operation of the St. Catharines system. We have few complaints of this type. When such a complaint does arise, we can generally point out that the variation is due to the consumer's own equipment or wiring and then it is his responsibility to take care of it.

*President Shearer:* What kind of instruments do you use?

*Mr. Yates:* A volt meter will show the fluctuation in the consumer's voltage whenever the refrigerator automatically cuts in or out. Variations will also be shown whenever his hot water heater cuts in or out. If he has an electric stove, he will see a flicker on his lights whenever the element is turned on or off. A domestic consumer will note these variations of the load on his own service, but he should not notice fluctuations in voltage due to variations in load on his neighbor's service. This, of course, applies to domestic circuits.

In the commercial districts, where the 5-h.p. refrigerator motors which are referred to, may be found, there is generally a motor large enough to require three-phase service, and we supply these by hooking a small transformer in open delta with a large transformer supplying the lighting service. This gives you a minimum cost for three-phase service, one small transformer and one additional wire. We find that there is such great diversity in this type of small three-phase motors in the commercial district that the added capacity is very inexpensive to install.

6. Do you control the location of service entrance on new houses?

*Mr. O. C. Thal, Kitchener:* The matter of controlling the location of services to new houses, I think, is quite important and quite necessary in that the local utility should have this pretty well in hand; that is, within reasonable limits, of course.

We have had no difficulty in securing the co-operation of contractor dealers and also of the building contractors in arranging the new houses so that the service entrance be placed in the position most conveniently reached from the closest pole. Of course, it does not necessarily hold that this location is the most advisable inside of the house. It may lead into a coal bin or some other location that is possibly not desirable for the location of the meter and the service entrance switch. However, extending the service with a short piece of conduit usually carries one through this difficulty.

In the matter of underground services, it is very important, of course, to have the service entrance brought in closest to the underground service box located on the street.

Also the matter of joint pole leads, I don't know how many municipalities represented here have done much of that. We, in Kitchener, have done some. In such cases, pole lines are usually constructed in the rear of the homes along the lot lines and the service in that case must be carried into the rear of the house rather than at the front of the house.

I don't know that there is anything else I can add at the moment.

7. Are graphic meters preferable to the demand (thermal) where customer's power factor is unstable and where customer is being penalized for power factor?

*Mr. A. B. Manson, Stratford:* In answer to question "7" on the questionnaire, "Are graphic meters preferable to the demand (thermal) where customer's power factor is unstable and where customer is being penalized for power factor?" — several items must be considered.

First of all, cost of equipment is a factor—graphic meter equipment is valued at approximately $500.00, while indicating thermal demand costs about $100.00. Maintenance on the thermal demand also is less, both in time and material, which is a consideration over a period of years.

Over against this extra capital and maintenance cost we have a permanent record for load analysis, a record of power factor conditions, a record of actual customer operating conditions relative to the town operation.

With graphic meters, the customer's power factor can be accurately determined on his peak for billing purposes and the consequent more accurate penalty.

Summing up, it appears to me that where the size of load or revenue is of sufficient proportion to warrant the extra cost, the graphic meter gives the preferable result.

*Mr. T. R. C. Flint, Toronto:* This is a very wide question. I was wondering what the party had in mind when submitting the question.

I do not like the word "penalized." I never use that word. I use "extra cost of power due to the consumer's equipment."

In the first place, I do not see where we need graphic meters, unless we are very particular in knowing the power factor at any particular time.

The way we handle demand measurements in Toronto at the present time is to install a kv-a. meter, if the power factor is known to be poor, and bill on a percentage of kv-a. If, however, the power factor is known to be good, we bill on the kilowatt basis. In the particular case in question, we might install both a kilowatt and kv-a. demand indicating meter.

Some of the larger consumers, however, require a graphic meter. We usually put in one graphic, reading kilowatts, and where necessary, a kv-a. demand meter to check power factor.

The two meters, of course, do not necessarily give accurate power factor, but give a billing basis.

I do not know anything else I can say. Of course, the cost of graphic meters is considerably higher than the cost of ordinary meters, but I hardly think the party who asked this question had costs of metering in mind.

* * * *

8. The Standard Interpretations of Rates authorizes three-phase power service for motors of less than 5 horsepower under certain conditions. Is it the general practice to charge only the rated horsepower of the motor in such a case? Should not the service charge be based on a minimum of five horsepower?

*Mr. O. H. Scott, Belleville:* Mr. Clement sent me this question and asked me to reply to it. I said I didn't think it was up to me to reply to it, I could only tell you my opinion in regard to Belleville.

You note the question asks what is the general practice? I can't tell what the general practice is. I think that is a question for the Commission engineers to deal with.

Our practice has been to charge on the rate of horsepower that is being served, when there are polyphase feeders running past the consumer's premises. When the consumer requires the Commission to provide transformers, he is charged for 5 h.p. if the load is 5 h.p. or less.

*Mr. R. L. Dobbin, Peterborough:* Mr. Scott got out of this pretty easy.

Section 45 of the Standard Interpretations of Rates says wherever the total installation of one customer is 5 h.p. or less, single phase horsepower will be supplied except when service can be given without the installation of secondary polyphase street lines.

This section is like a lot of sections here, it is capable of two or three interpretations, so we ought to have another pamphlet called, "The Interpretation of the Standard Interpretations of Rates."

It goes on to say wherever it is necessary to install a feeder or transformer to serve one customer, single phase power will be supplied. It says

here that you will give the service to a polyphase 5-h.p. motor or less where you do it without the installation of polyphase secondary street mains.

If that means exactly what it says, then the customer can demand three-phase power and you will have to hang two transformers to give him that three-phase power because you won't have to install any polyphase secondary, in that case.

However, the practice in Peterborough is that we do not give polyphase power for 5 h.p. or less unless it happens to be in that location already installed. I think that is the meaning of the section.

As far as I can see, that is the meaning of the question. I agree with Mr. Scott, if you already have the polyphase power available for use in that locality, then you should charge them only for the rate of horsepower in the motor. If it should happen you have to go to quite considerable expense to give three-phase power, and there are some installations that require three-phase power, like motor-driven gasoline pumps of large capacity, they really have to have three-phase power, and in that case I think you should charge for the 5 h.p.

* * * *

9. What is the general practice used in reckoning power service change on a store with a 5 horsepower elevator motor and a 3 horsepower refrigerator motor?

*Mr. D. E. Charters, Windsor:* In Windsor, platform elevators are charged their full horsepower rating up to 5 h.p. Platform elevators from 5 h.p. to 10 h.p. are charged for 5 h.p. Platform elevators 10 h.p. and over are charged for one-half their horsepower rating. If the total horsepower of other motors, plus half the rating of the elevator equals 5 h.p. or more, then half the rating of the elevator motor is charged.

With a 5-h.p. elevator motor and a 3-h.p. refrigerator motor, we would charge on 3 h.p. plus one-half of 5 h.p. or a total of 5½ h.p.

* * * *

10. Is it common practice to have a physical or actual valuation made of the distribution system and substation equipment at given intervals of time, or do we depend solely on book valuation? What's your opinion?

*Mr. C. E. Hodgson, H.E.P.C. of Ont., Toronto:* Mr. Bond has been detained at the Accounting Session. In his absence, he has asked me to read his comments on Question No. 10.

It is not common practice to have a physical or actual valuation made of the distribution system and substation equipment at given intervals of time in respect to Hydro Municipal enterprises. We depend on the book valuation, because of the fact that we are dealing primarily with costs, rather than present values.

Most of the equipment has been financed by issuing debentures maturing over a period of years and the annual charges must of necessity be pro-rated during the life of the debentures.

Renewals due to depreciation or obsolescence are provided for in the depreciation reserve. Any increase

in cost may, of course, be capitalized, provided the life of the equipment so renewed is estimated to be reasonable.

When the debentures mature, the equipment can be written down to valuation and thus relieve the operations of a proportion of the charge in respect to depreciation reserve. This would also have an effect in the pro-rating of the operating expenses against the various phases of operation. This procedure is not generally resorted to, as the original costs would, of course, be materially disturbed.

In my opinion, it is quite proper to deal with costs in Hydro Municipal operations. As a matter of fact, we have no alternative because the whole structure is based on costs. If we were primarily interested in the distribution of dividends based on surplus or profit, that would be entirely another matter of policy and an adjustment of the plant accounts from time to time might then be justified.

* * * *

11. Have you had difficulty with Clause 14 Standard Interpretation of Rates regarding combined business and dwelling premises when an electric stove is used and the business load is comparatively low yet in excess of 200 watts?

*Mr. P. B. Yates, St. Catharines:* This question is one of the old perennials that has been discussed whenever a revision of the Standard Interpretations of Rates has been considered.

For a number of years there have been before the Engineers of the Hydro-Electric Power Commission, various revisions of this paragraph, Clause 14. At the present time, the wording of the regulation is more adaptable for village and rural systems than it is for urban systems. The revision proposed by the Rates Committee in 1937, awaiting the action of the Hydro-Electric Power Commission, gives us another interpretation which may or may not be authorized. Personally, I am opposed to the adaption of the Clause as it is now proposed to the Hydro-Electric Power Commission.

The proposed revision calls for prorating the consumption of a combined domestic and commercial service, splitting the consumption between the domestic and commercial rates. Estimating consumption in an emergency is sometimes necessary and can be justified, but to estimate *each month* the split of the total kw-hr. between the domestic and commercial is an impractical system and is bound to to cause constant argument with your customers.

This is another one of those clauses of the Standard Interpretation of Rates that, in my personal opinion, should be simplified.

* * * *

12. Have leaking water tanks been any particular problem since the installation of flat rate heaters?

*Mr. A. W. J. Stewart, Toronto:* I would say, as far as Toronto is concerned, the answer to that question is, No.

When the Toronto Hydro started with the water-heater campaign, it was decided that the System would

supply a tank as part of the equipment in addition to supplying the heater and the thermostat and the other equipment.

The rate was made to cover the supplying and the maintenance of the tanks and other equipment as well as the current used.

As we have gone on, we still think that the proper plan is to supply a tank. I don't want to break in on No. 13, which Mr. Rhoads is evidently going to answer, but there are a number of reasons why the tank usually found on the consumer's premises is not suitable for this job. These include wrong location of openings and probable age of the tank. We haven't been going long enough to estimate accurately the probable average life of the tanks, but so far our experience has been relatively satisfactory.

There are a number of considerations that enter into the fixing of the rate. I don't remember now any definite figure that was included for supplying the tanks. The rate was fixed nearly five years ago, but there is a municipality some place—I think it is Oshawa—supplying tanks at the customer's option at a definite rate per month. I believe it was 15 cents a month for a No. 40 tank.

*   *   *   *

13. Do you feel that flat rate water tanks should be owned by the Commission?

*Mr. F. S. Rhoads, Windsor:* In answer to this question, we feel that the Commission should own the flat rate heater equipment and tanks; the reasons being as follows:

1. The tanks that are installed in the average home are too small to take care of the supply for the house when a small flat rate heater is installed.

2. When the tank in the house is used, we do not know its age and after the installation is made and the tank insulated, very often after a short period, the tank begins to leak. We also find in putting in the flat rate equipment, material that has been installed for years is broken, and we are expected to replace this with new. Therefore, if we leave the customer's tank intact and use it as a tempering or settling tank, we eliminate trouble.

3. When the Commission installs the tank, the correct size necessary to take care of the demand is installed. These tanks vary in size from 40 gallons up to 100 gallons, and the customer pays a rental that will pay for the installation over a period of years.

4. When the Commission installs the tank, it is completely equipped in our stockroom and ready for service. Therefore, we do not have loss of material, such as wool, through leaking tanks, heaters being broken, etc., after we are asked to remove the equipment from the home.

5. In most cases in our city, the customer's tank is placed near the furnace. This may not be in the proper place to give the best results, so when we supply the tank, the plumber places it to give the maximum service.

*Mr. G. J. Mickler, H.E.P.C. of Ont., Toronto:* Mr. Rhoads has covered the

subject of Hydro-owned water tanks fairly well, but there are a few points he did not mention, which I think are worthy of note.

Some disadvantages of customer-owned tanks may be cited as follows:

1. Customers' tanks in many cases are of questionable age and their condition inside is unknown, and while the customer in signing a water-heater contract agrees to provide a tank suitable for water-heater purposes, and agrees to maintain such a tank, or to replace a leaky one, nevertheless, some risk is assumed by the Local Commission in utilizing a customer's tank, and the cost of maintenance may rise beyond the limit of economical operation. When the Local Commission goes to the expense of putting Hydro equipment on a customer's tank, it expects the tank to last a reasonable length of time. It is not possible to predict the life of an ordinary standard tank.

2. For satisfactory water-heater service, a tank of proper capacity is required, and when customers' tanks are too small, good service cannot be given. In a great many cases, the customer's tank is an ordinary 30-gal. boiler, which was never intended to be large enough for adequate hot-water service.

3. The position of holes in a customer's tank may not be suitable for the type of heater required, necessitating the installation of strap-on heaters, or putting one or more spuds in the proper places, both of which add to the cost of the installation.

### Some Advantages of a Hydro-Owned Tank

1. A Hydro-owned tank can have all the equipment installed in the workshop and taken out to a job and installed with the minimum of expense and a better job done.

2. A Hydro-owned tank is made to specifications to insure long life and satisfactory service.

3. The Local Commission can locate a Hydro-owned tank near the risers to the kitchen and the bathroom, thus insuring maximum efficiency of the installation.

4. When a tank fails, the whole assembly can be removed and replaced at a minimum of expense.

5. When the customer discontinues the use of the service, the Hydro tank can be removed and the customer's tank put back into service at a minimum of expense.

6. If the original tank is too large or too small, it can be changed without consulting the customer or interfering with his plumbing, thus saving expense for him.

*(To be continued)*

# Clean Streams—A National Asset

By Morris M. Cohn, Sanitary Engineer, City of Schenectady, New York, and Editor Municipal Sanitation

THIRTY years ago, Tell Taylor, a native of Ohio, lounged on the banks of an old mill stream, dreamed of his lady-love, and composed a song that you and I whistled and that engaged the vocal efforts of more barber-shop quartets than even "Sweet Adeline." The Old Mill Stream struck a responsive chord in all of us; somewhere in our boyhood days we all carved initials in trees that overhung a stream. . . .

That was thirty years ago. . . . To-day, the sweetheart in gingham gown is replaced by a girl who scorns such simple attire. . . . The old waterwheel is wiped away in the inevitable march of power progress. . . . The mill river is polluted and mosquito-ridden. . . . The dead fish that clutter its turbid waters are not in tune with romance.

To-day, the old swimming hole, where we tied knots in the gang's clothes, is no longer fit for such bathing. . . . The trout don't bite any longer in our favorite boyhood stream. . . . Canoeing with one's lady-love may be embarrassing, even to our blasé and shock-proof modern youth.

The Old Mill Stream is merely our "springing board" into a discussion of how man has loved his streams so well that he built his cities on their banks and then polluted them; how we have, vampirishly, bitten the "hand" that feeds us.

Our watercourses have been the nerve-centre of man's progress from primitive day to this. To the shores of streams came nomadic man to pitch his tent, to drink of its waters, to traverse its length, to take food from its depths. It is small wonder that when man forsook his nomadic state, he chose the shores of streams as his community sites. It offered him the basic essentials of life; food, water, transportation, and clean environment.

It is small wonder also that man should love the streams that he called home. Every people has expressed its love of its native waters in songs that have become national anthems, in their significance.

The Egyptians worshipped the Nile, the Romans the Tiber, the Israelites the Jordan, the Germans the Rhine, the Irishmen the Shannon, the Russians the Volga. Mention any list and you will be condemned by some ardent national for omitting his own beloved stream.

In our own melting pot, many of the pot's pot-pourri ingredients recall consciously, or subconsciously, some nostalgic chant to other lands and other streams, yet we have vied with each other in eulogizing our streams.

The beloved Suwannee, the beautiful Ohio, the powerful Niagara, the murky Missouri, and the mystic Ol' Man River himself have all been eulogized by those who inhabited their shores.

That was thirty years ago. We can no longer string the lyre and sing of our streams, unless it be a song concocted by a song-mechanic of Tin Pan Alley, who, never having been beyond the confines of New York's humming canyons, chooses to write a lyric about the Rio Grande, because it rhymes with "nice and dandy."

The filth-ridden communities of the Middle Ages wallowed in the wastes of life. Sewage was discharged directly into the streets, and disease stalked ankle-deep in the ooze and wiped its feet on the doormats of thousands of homes. The modern community has learned that the price of community life is community cleanliness; every community has provided hundreds of miles of sewers to remove instantly from the homes the befouled waters which carry the wastes of living, of industry, and of commercial activity.

Communities have poured these liquid wastes into the streams that flow past their shores, the same streams that originally acted as magnets to the early settlers. Streams have become seriously polluted from the staggering organic load of the wastes of life and living, and the dangerous wastes of our complex industrialism. The backdoors of our proudest communities are not fitting companions for their gleaming boulevards and parks.

Communities have made light of the old common law of riparian rights. Upstream communities have discharged wastes into and lessened the value of the streams for their downstream neighbors. These neighbors have, in turn, given little thought to the justice of keeping the watercourse undiminished in quantity and unimpaired in quality.

The discharge of such wastes into watercourses has resulted in the spread of disease, the destruction of fish life, the endangering of animal life, the degradation of historic values, the curtailment of recreational facilities, the shocking of the senses, and the depressing of property values.

Stream pollution has been condemned, by lay and professional circles alike, for many reasons. Devoid of technical terminology and stripped of complex ramifications, stream pollution stands condemned as the destroyer of the basic essentials of life. Upon this ground, alone, we should destroy water pollution before it destroys us.

There are three basic essentials of life. Given them, man survives; without them, he perishes.

Man needs an adequate supply of safe water, a supply of safe food, and a healthful environment. Without water, life is impossible; without food, improbable; without decent environment, undesirable. The difference between the desert and the populated land is water. The difference between a famine-ridden land and a land of plenty is food. The difference between the unsuccessful, befouled cities of the Middle Ages and our

present successful urban life is healthful environment.

Water is the major essential of life. early man found his supply in a spring, a rippling brook, or a large river. Its purity was unquestioned. In the pastoral state, this simple means of water supply was augmented by man's ability to tap the dependable supply of underground water available to his dug or driven well.

The community of to-day rests on a foundation of an ample supply of safe water. The major percentage of communities derive this water from rivers and lakes. Thus, the pollution of these waters by sewage has a direct bearing on the quality of water supplied to consumers. Sometimes the pollution affects the water supply of the community that contributes the sewage contamination; frequently, communities injure the supply of their neighbors.

In order to safeguard urbanites from the dangers of polluted water supplies, some communities have set up systems for purifying the water prior to its discharge into the supply lines. Ingenious and dependable methods have been provided for the removal of visible solids, turbidity, color, odor, and dangerous micro-organisms and microscopic animal and vegetable life.

It is startling, indeed, to compare the quality of "raw" water entering these water-purification plants with the sanitary and presentable liquid being delivered to the consumers. With greater knowledge on the part of the consumers, both domestic and industrial, there has arisen a demand for water which is palatable and attractive and which has a mineral composition that does not interfere with the industrial life which is the backbone of the community.

However, even these ingenious devices of sanitary science cannot cope with gross pollution, and municipalities have been compelled to desert nearby waters and develop supplies hundreds of miles away, where the polluting effect of man is not yet felt. While the plagues of an earlier age have been stamped out, we have experienced enough modern water-borne epidemics to convince us that the water-purification method is not the complete answer to stream pollution. We must correct pollution if we are to have a dependable supply of the major essential of life.

Food is another essential of life which is endangered by polluted streams. The disposal of untreated waters into streams results in putrefaction which robs the waters of the life-giving oxygen which fish need. In addition, wastes often poison and suffocate fish and untold numbers are victims of man's influences.

For example, the development of shellfish is a basic American industry and the product is a valuable food supply for our people. These breeding areas are easy victims of sewage and industrial-waste pollution and many have been condemned by health authorities as transmitters of disease.

The development of cattle makes proper watering essential. It is unfortunate that this source of food is indirectly endangered by the pollution of natural streams used by cattle.

In these ways, and in others, polluted streams are a menace to the food supply of the nation.

We have learned that we cannot live successfully amid the environment of our own physiological wastes. Rivers, lakes, and coastal waters which are contaminated produce unhealthful environment as surely as though these materials were disposed of upon our native soils. We cannot live successfully or pleasantly if we bathe in polluted waters, or if polluted waters wash our shores. We need the release from the tension of modern life which is provided by boating, fishing and camping. Anything which interferes with this relaxation is destructive of life.

Here, then, is the problem. The pollution of our streams is destructive of our ability to live happily, contentedly and well. Grave economic losses have resulted from increased cost of water purification, destruction of bathing facility investments, destruction of food sources, and reduction in property value. In addition, the impairment of the quality or quantity of the essentials of life lends new significance to the warning that "The American people must destroy stream pollution before it destroys us."

What is the answer? We cannot destroy life because it produces a dangerous waste, nor can we destroy industry because of its wastes. The answer is the installation of adequate sewage and waste-purification plants to remove dangerous constituents from these liquids before they are discharged into bodies of water. The prevention of pollution by the use of sewage-treatment facilities will result in cleaner and more sanitary streams and will remove the dangerous overload on the water-purification plants located downstream from the sewage discharge.

This method of safeguarding the purity of streams is rapidly being adopted. The past few years have witnessed construction of hundreds of sewage-treatment plants and an impressive number of private industrial waste-treatment works.

Slowly, but surely, we are wiping out the national shame of polluted waters, but it will take the power of public opinion to eventually outlaw this menace to our security and welfare. When every thinking citizen revolts against the use of rivers, lakes and coastal waters as common sewers, then and only then will we return this national resource to decent condition and safeguard the civilization we are so proudly developing.—*General Electric Review.*

# Insulated Cables for Power Distribution and Street Lighting Circuits

By O. W. Titus, Chief Electrical Engineer, Canada Wire and Cable Company, Ltd.

*(Presented to the Association of Municipal Electrical Utilities at Toronto, February 9, 1938)*

*(Continued from February)*

C.8. *Ducts.* Ducts would require a lengthy paper in themselves. They offer the best means of protecting lead sheathed cables, underground, from mechanical damage. They are preferred construction on this continent as permitting—

a. Only opening street or pavement once.

b. Ease of installing additional cables.

c. Ease of Replacement.

d. Ease of Repair.

Practice in Canada is mainly to use fibre or single clay tile duct set in concrete. 1,000 pound concrete is used for the duct envelope; 3,000 pound is recommended for manhole walls and roof.

Duct inside diameters should be one-half inch greater than the cable outside diameter.

Minimum radius of curvature in training cables should be about twelve times the diameter of the cable.

Distances between manholes run from 250 ft. to 500 ft. depending on local conditions, although in some cases, 750 ft. lengths are used.

Minimum depths to top of duct structures recommended by H. P. Seelye are:

| | Inches |
|---|---|
| Below Surface of Pavement | 30 |
| Below Dirt Surfaces (allow 30 inches below any future pavement surface) | 36 |
| Below Sidewalks | 36 |
| Below Dirt Surfaces of Private Rights of Way | 30 |
| Below Driveways on Private Rights of Way | 36 |
| Below Street Railway Tracks (base of rail) | 24 |
| Below Steam or Electrified Railroad Tracks | 42 |

Grade of conduit from manhole to manhole—4 inches per 100 ft. Figs. 7, 8 and 9 illustrate typical duct, manhole, and riser sweep cross sections and installation methods. The reader is referred to "Electrical Distribution Engineering" by H. P. Seelye (from which Figs. 7, 8 and 9 are abstracted) for more complete details on ducts and manholes.

Armouring of course is not necessary when ducts are used. In fact, D.S.T.A. cables should not be pulled into ducts excepting in very short lengths due to the liability of setting

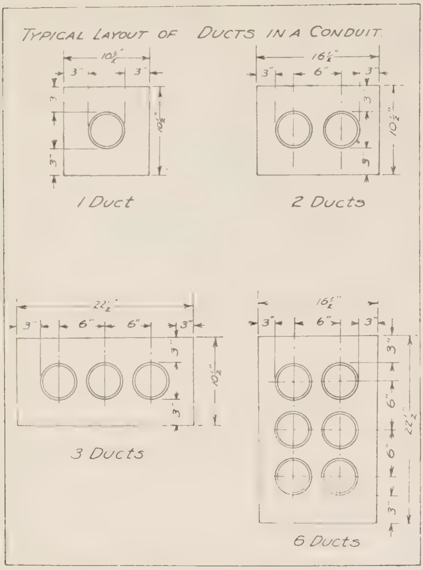



*Fig. 7*

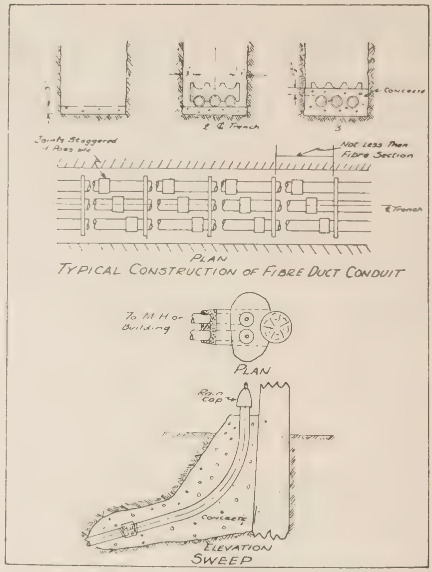



*Fig. 9*

up excessive pulling stresses and of jamming in the ducts.

D. Cable Types and Applications

From these insulations, sheaths, and protective materials, we derive the following main classifications of cable. We will not attempt to enumerate all the individual trade names and variations in detail:—

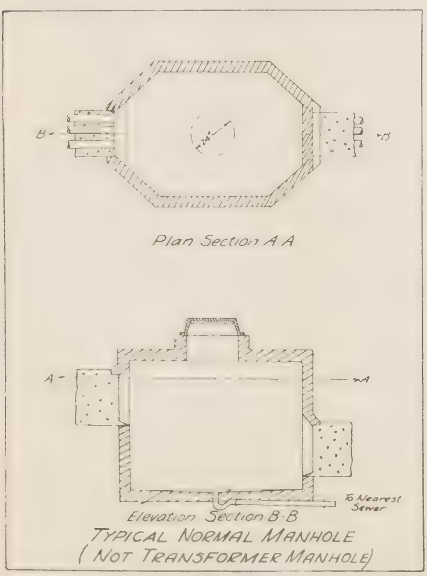



*Fig. 8*

(a) Impregnated paper, rubber or V.C. insulated and lead covered. (P.I.L.C., R.I.L.C., or V.C.L.C.).

(b) Same as "a" plus jute wrap, double steel tape armoured, and jute wrapped, all heavily asphalt plastic impregnated and coated. (P.I.L.C. D.S.T.A., R.I.L.C. D.S.T.A., or V.C. L.C. D.S.T.A. "Parkway").

(c) Same as "a" plus jute wrap and heavily asphalt plastic coated. (P.I. L.C. Jute, R.I.L.C. Jute or V.C.L.C. Jute).

(d) Same as "a" plus jute wrap, galvanized steel tape armoured, (minimum of impregnant in jute). (P.I.L.C. Industrial, R.I.L.C. Industrial, or V.C.L.C. Industrial).

(e) Same as "a" plus jute wrap and galvanized steel wire armoured,

(usually no jute overall). (P.I.L.C. S.W.A., R.I.L.C. S.W.A., or V.C.L.C. S.W.A.).

(f) Rubber insulated, taped and braided. (R.I.B.C.).

(g) Varnish cambric insulated, taped and braided. (V.C.B.C.).

(h) Rubber insulated—plus various combinations of cotton or jute braids and wraps and asphalt plastics—non-metallic sheathed underground cables.

(h1) Rubber insulated tape or impregnated braid, asbestos base caulk, asbestos braid, asbestos base caulk, pressed fibre armour, asbestos base caulk, impregnated duck tape. "Trenchlay."

(h2) Rubber insulated, tape or impregnated braid, asbestos base caulk, jute braid, asbestos base caulk, impregnated duck tape. "Modified Trenchlay."

(i) Hard copper or alloy conductor, rubber insulated, taped, copper shielding tape, braid impregnated—self-supporting primary cable.

(j) Rubber insulated, taped (often pressed fibre armour) hard corded braid impregnated—Tree Wires.

Preferred Cable Constructions for various uses are listed below. It should be understood that these are not hard and fast, but rather a general guide.

*Preferred Insulation by Voltages*

All voltages—Impregnated paper.

Up to 15,000 volts—Impregnated paper or varnished cambric.

Up to 5,000 volts—Impregnated paper, varnished cambric, or rubber.

*Based on Installation and Service Conditions*

A.1. Underground in Ducts—P.I.L.C., V.C.L.C. or R.I.L.C.

A.2.a. Normal Soil Conditions—All insulations lead covered and D.S.T.A. Parkway; all insulations lead and jute covered; Trenchlay; modified Trenchlay.

b. Acid Soil Conditions or in soils containing considerable organic matter—Trenchlay; Modified Trenchlay.

c. Free Alkalines contained in soils due to manufacturing processes, etc.—Trenchlay; Modified Trenchlay.

d. Soil with oil present—D.S.T.A. Parkway; lead and jute covered cables.

e. Street Lighting Circuits.
Series up to 15 Amps.—D.S.T.A. Parkway Cable, lead and jute covered cables, (single-conductor usual); Trenchlay; Modified Trenchlay.
Series over 15 Amps.—D.S.T.A. Parkway Cable (single-conductor not permissible); Single or Multi-Conductor Trenchlay, or Modified Trenchlay.
Multiple—One, two or three conductor D.S.T.A. Parkway Cable; lead and jute covered cable; Trenchlay, or Modified Trenchlay. (N.B. Under some conditions, the lead sheath or a separate bare wire may act as the neutral).

B. Overhead on Poles—P.I.L.C., V.C.L.C.. or R.I.L.C. (usually with 1 per cent antimony in the lead sheath).

1. Suspended from Messenger Wires.
2. Self-Supporting (up to 5,000 Volts)—Self-Supporting Primary Cable; Tree Wires.
Service Drops—Special R.I.B.C. Types; Special Impregnated Braid Types.

C. In Buildings, 1, Wet
1a. Protected—P.I.L.C., V.C.L.C., R.I.L.C.
1b. Not Protected—D.S.T.A., Industrial Cables.
In Buildings, 2, Dry.
2a. Protected—R.I.B.C., V.C.B.C.
2b. Not Protected—D.S.T.A., Industrial Cables.

D. Submarine Cable—Steel Wire Armoured over P.I.L.C., V.C.L.C., or R.I.L.C. (in some cases, the lead sheath is omitted in Rubber Insulated Submarine Cable).

### CURRENT CARRYING CAPACITIES

The size of conductor is governed by the current to be carried. The three following criteria should be applied in choosing the size of conductor:

a. Will the size chosen carry the current without overheating the cable?

b. Will the size chosen carry the current the distance required without excessive voltage drop?

c. Is the size chosen the most economical, bearing in mind annual capital and interest charges and the cost of power consumed in resistance losses?

*a.* The $I^2R$ losses in the cable conductors must be dissipated through the insulation, through any surrounding medium and to the earth at some distance if underground or to the air if above ground. The watts of heat developed passing through the thermal resistance of the various cable surroundings cause a temperature rise (Ohm's Law for Heat), and we must design our cable so that this temperature rise added to the soil or air temperature as the case may be, do not result in temperatures at the conductor surface higher than the following:

Impregnated Paper—90 deg. cent. minus E with a maximum of 85 deg. cent.

Varnished Cloth—75 deg. cent. minus E.

Rubber—60 deg. cent. minus E/4.

(Where E is the voltage in kilovolts, between phases for multi-conductorbelted cables, and from conductor to neutral for single-conductor or multi-conductor shielded cables.)

For those wishing to study this subject, we recommend D. M. Simmons well known "Calculation of Electrical Problems of Underground Cables" published in the Electric Journal during 1932, copies of which are available.

Graphs Nos. 1 to 12 show such current carrying capacities for three-conductor lead sheathed cables based on a reasonable average soil ambient temperature for summer conditions in these latitudes of 20 deg. cent. (68 deg. fahr.) and an average daily load factor of 75 per cent. For cables in air, the ambient air temperature has been taken as 40 deg. cent. (104 deg. fahr.), which is the usual value assumed, excepting where the cable is exposed to the direct rays of the sun, in which case, 45 deg. cent. (113 deg. fahr.) at least should be assumed. Correction factors are shown for other air temperatures for cables in air.

Do not forget that a riser section may limit the current carrying capacity of the whole line, unless it is pro-

tected from the sun and brought up in a cool location.

Current Carrying Capacities for four-conductor cables, two-conductor cables, and for three-conductor cables, with only two conductors carrying most of the load (as with a properly balanced single phase three wire system) may be reasonably well approximated by the correction factors shown on the graphs.

These graphs are:

| Graph No. | Working Pressure | Conditions |
|---|---|---|
| 1 | 600 Volts | *Three* 3 phase cables in *one duct bank.* |
| 2 | 4500 " | " " " " " " " |
| 3 | 15000 " | " " " " " " " |
| 4 | 600 Volts | *One* 3 phase cable in one *duct bank.* |
| 5 | 4500 " | " " " " " " " |
| 6 | 15000 " | " " " " " " " |
| 7 | 600 Volts | *One* 3 phase cable buried *directly in earth.* |
| 8 | 4500 " | " " " " " " " " |
| 9 | 15000 " | " " " " " " " " |
| 10 | 600 Volts | *One* 3 phase cable in *Air.* |
| 11 | 4500 " | " " " " " |
| 12 | 15000 " | " " " " " |

being extremely low due to the close spacing of the phase conductors, cables have a distinct advantage over overhead construction and usually regulation is not the main criterion excepting with street-lighting circuits. However, Graphs Nos. 13 and 14 (respectively for 25 cycles and 60 cycles) give a ready means of checking conductor size based on voltage drop. While these are actually based on 600 volt rubber or V.C. insulation, the error is so small in applying them throughout the range covered by this paper that we may neglect it.

It will be noticed that paper cables have a distinctly higher current carrying capacity than V.C. and V.C. in turn higher than rubber. As paper cables can be made in smaller diameters with sector conductors, a further advantage in cost favours their use. If we consider the cost of carrying one ampere a thousand feet (by cables installed in ducts), we find that if we make paper cable 100 the costs of the other insulations would be somewhat as follows:

Their use is simple. Multiply the number of amperes by the distance in feet. Find this number on the vertical scale. Go out horizontally to the diagonal line corresponding to the size of conductor and read the volts drop directly below on the horizontal scale. For single phase, multiply the results so obtained by 1.16.

| Voltage | Paper Insulated Cables | V.C. Insulated Cables | Rubber Insulated Cables |
|---|---|---|---|
| 600 | 100 | Approx. 120 | Approx. 145 |
| 15000 | 100 | " 220 | |

*b.* A cable may be quite capable of carrying the current without overheating but give too great a voltage drop. The reactance of cable circuits

*c.* Kelvins Law (slightly restated to be applicable to cable) that the annual cost of energy lost due to $I^2R$ losses in the conductors should not be

greater than the annual cost of capital writeoffs plus interest charges should be applied to ensure the best use of the purchaser's money. However, this consideration will not be enlarged on here, as it is dependent on the cost of power as well as the cost of cable and is general and should be applied to any conductor carrying power.

### EXAMPLES

As an aid to utilizing the curves, we give the following numerical examples,

*Example No. 1.* What size paper-insulated lead sheathed cable should be chosen for the following:

| | |
|---|---|
| Distance | 2500 feet |
| Load | 1000 kw, 3 phase at 80 per cent. power factor |
| Voltage | 4000 volts |
| Daily Load Factor | Will not exceed 75 per cent. |
| Max. Permissible Voltage Drop | 5 per cent. |
| Frequency | 25 cycles |
| Installation | Duct |
| Number other cable dissipating Heat in Duct | None |
| Ends brought up where air temperature at time of max. load will not exceed | 30 deg. cent. (86 deg. fahr.) |

Current per Phase ........ $\dfrac{1,000,000}{4000 \times \sqrt{3} \times 0.8} = 181$ amperes

From Curve 5, a 3/C No. 00 B&SG cable has a current carrying capacity of 200 amperes.

From Curve 11, a 3/C No. 00 B&SG cable has a current carrying capacity at 30 deg. cent. in air of $.180 \times 1.095 = 197$ amperes.

Ampere $\times$ Feet $= 181 \times 2500 = 452{,}500$.

From Curve 13, volts drop for No. 00 = 74.

Regulation, % $= \dfrac{74 \times 100}{4000} = 1.85$

The 00 B&SG. P.I.L.C., 4000 volt cable would be the logical choice, unless future growth indicated a larger size is warranted.

*Example No. 2.* A cable is required to supply a street lighting section underground in the boulevard:

| | |
|---|---|
| Distance | 1500 feet |
| Average spacing | 75 feet |
| Size Lamps | 200 watts |
| Voltage | 115/230 |
| Frequency | 25 cycles |
| Max. Permissible Voltage Drop | 5 per cent. |

Total Load ........ $= \dfrac{1500}{75} \times 200 = 4000$ watts.

Drop at end lamp is equal to the drop at the load centre if all lamps were concentrated at the load centre.

Load Centre = 750 ft. from supply end (uniformly distributed load).

Current ........ $= \dfrac{4000}{230} = 17.4$ amperes.

Permissible Drop ........ $= .05 \times 230 = 11.5$ volts.

Amperes $\times$ Feet ........ $= 750 \times 17.4 = 13{,}050$.

Referring to Graph No. 13, our single phase permissible drop of 11.5 volts must be divided by 1.16 to find the equivalent 3 phase drop to use with the graph.

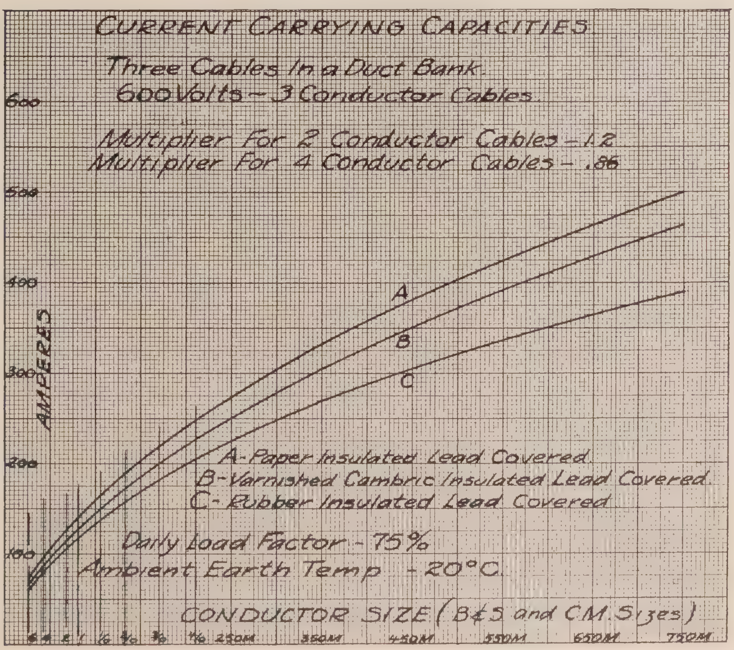
$$\text{Equivalent 3 phase drop} = \frac{11.5}{1.16} =$$

10 volts practically.

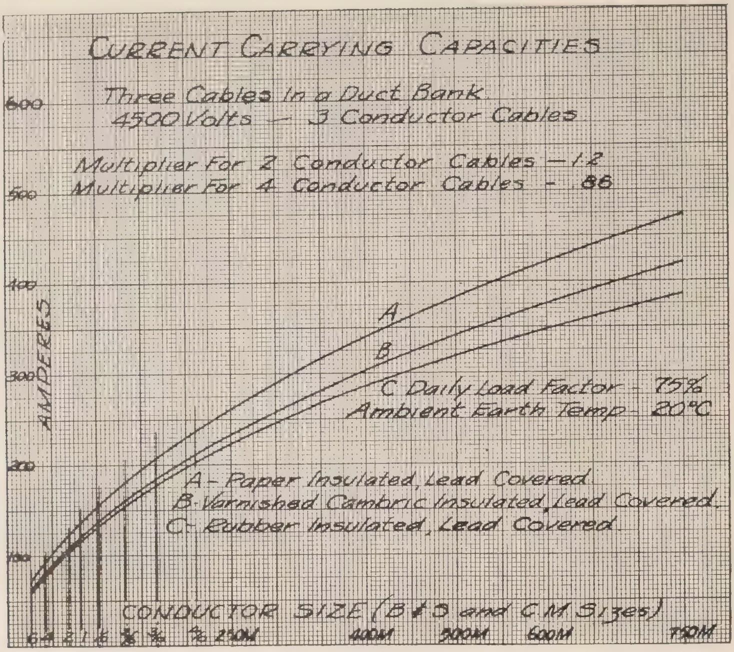
A two-conductor No. 4 B&SG. rubber insulated lead covered D.S.T.A. cable with lamps connected alternately between the respective conductors and the lead sheath would give slightly better regulation than required, No. 6 being not quite good enough. The lead sheath with this scheme would only carry the current of one lamp to the next, a matter of less than 2 amperes which it will do without trouble.

Checking from Graph No. 7, it is apparent that the No. 4 B&SG. cable will carry the 17.4 amperes maximum by a wide margin without overheating.

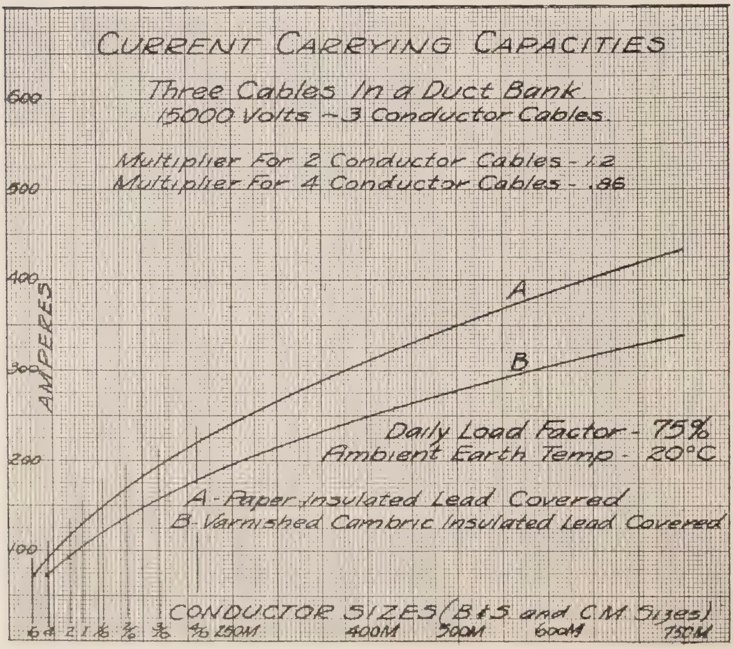
Alternatively, a two-conductor No. 4 B&SG. rubber-insulated, lead sheathed and jute armoured cable, or a two-conductor No. 4 B&SG. Trenchlay or Modified Trenchlay cable could be used with a bare wire buried alongside it for a neutral. These non-metallic sheathed cables however one cannot expect to have as long a life and troubles are more difficult to locate than with a metallic sheathed cable.



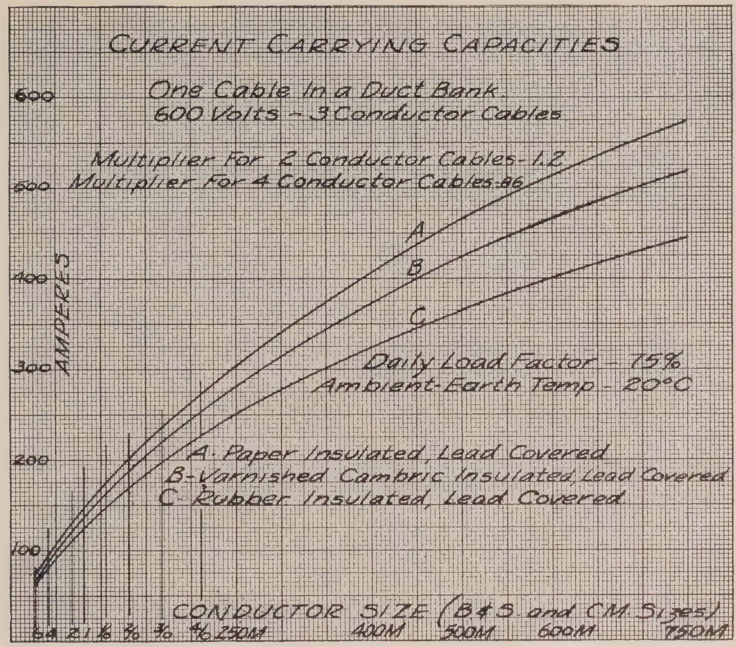

*Graph No. 1*



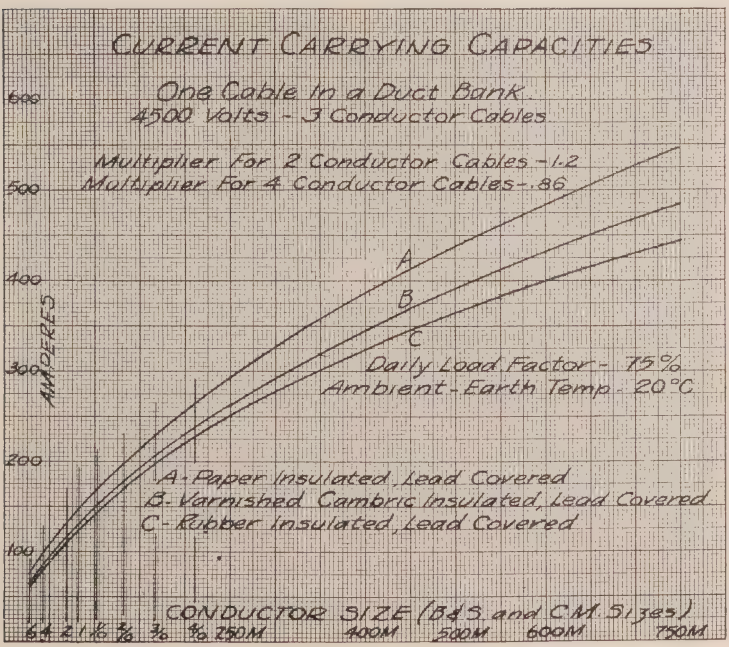

Graph No. 2



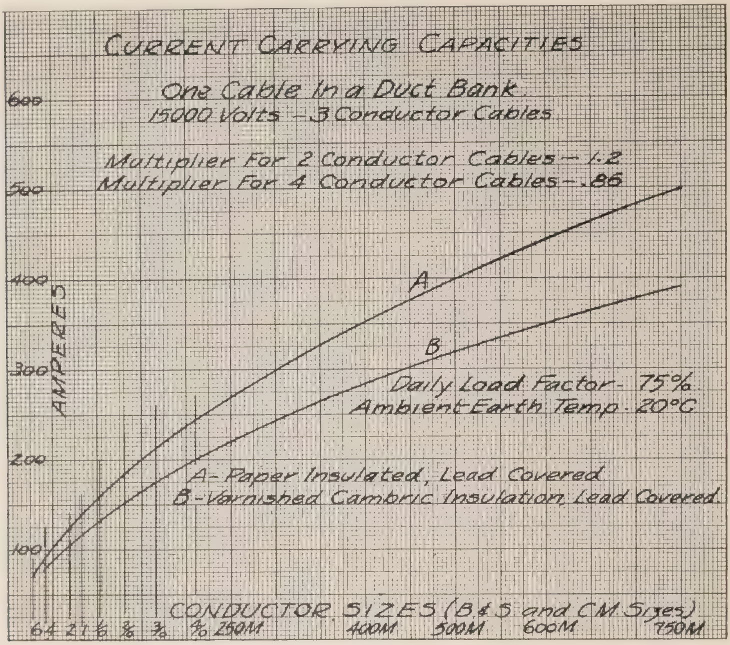

Graph No. 3



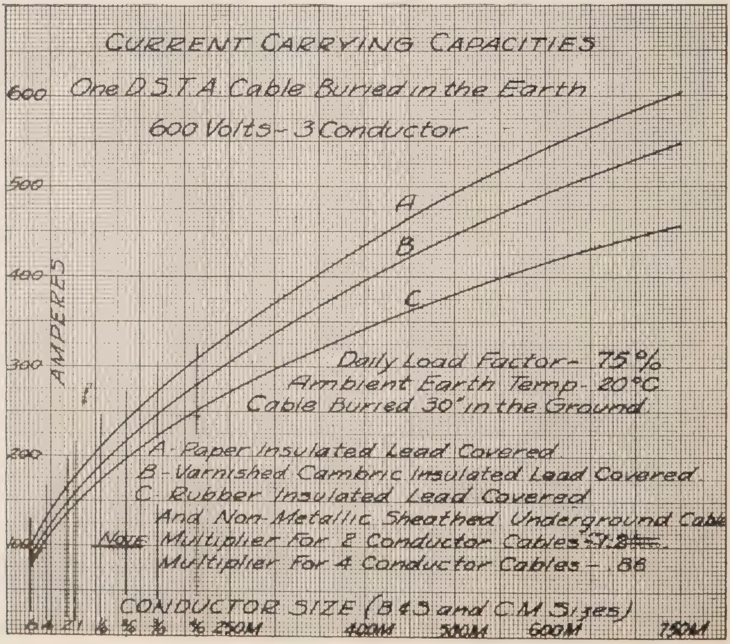

Graph No. 4



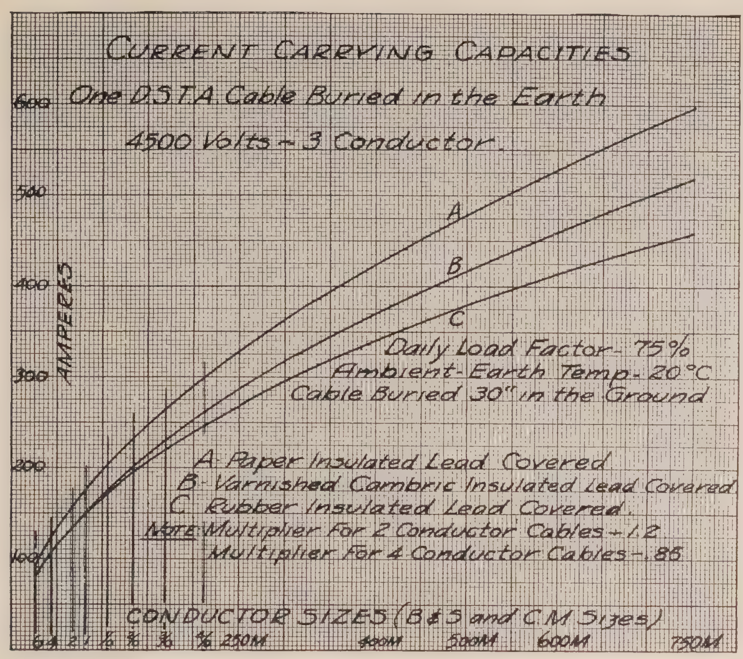

Graph No. 5



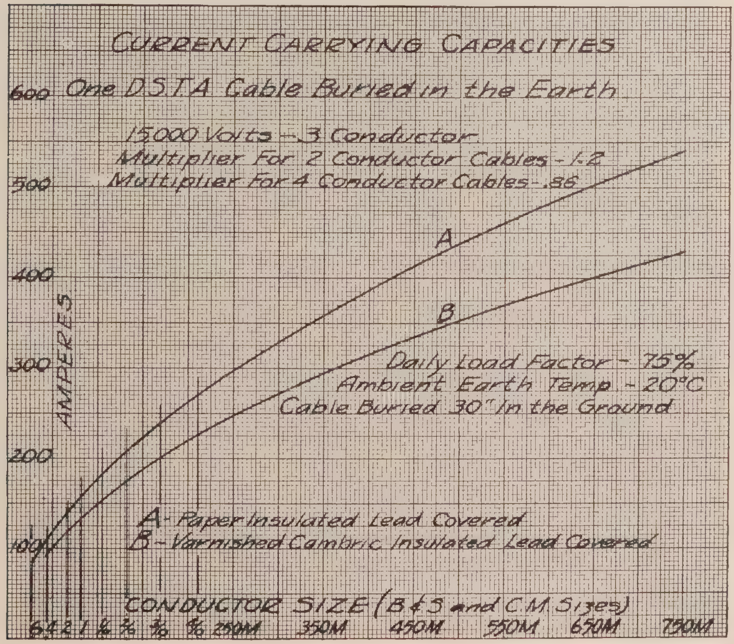

Graph No. 6



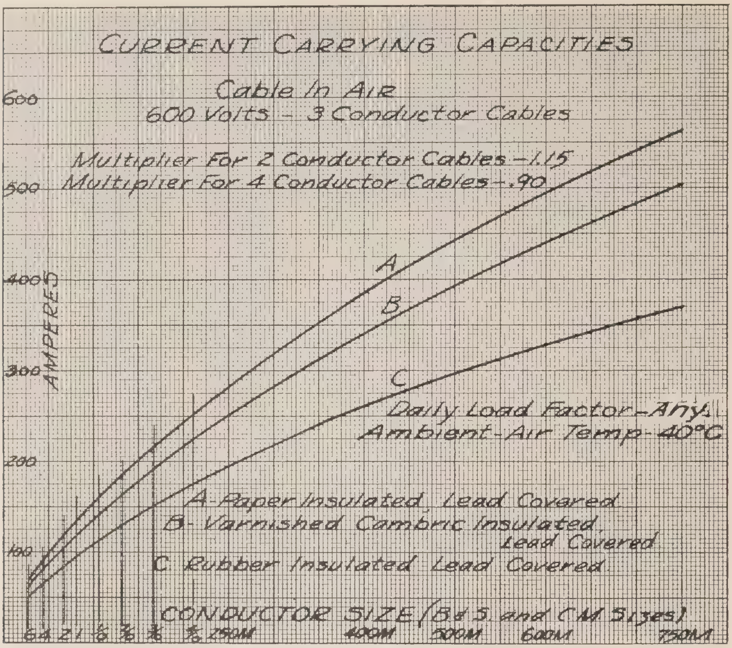

Graph No. 7



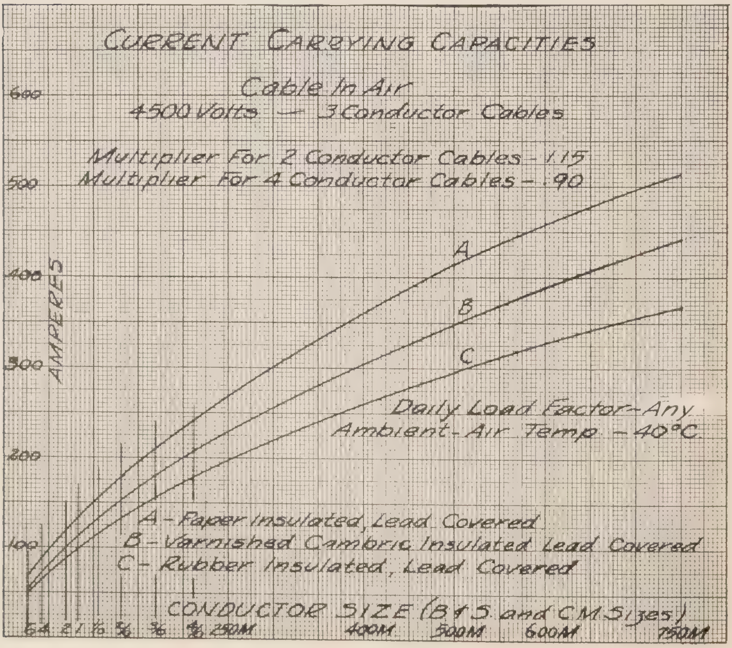

Graph No. 8



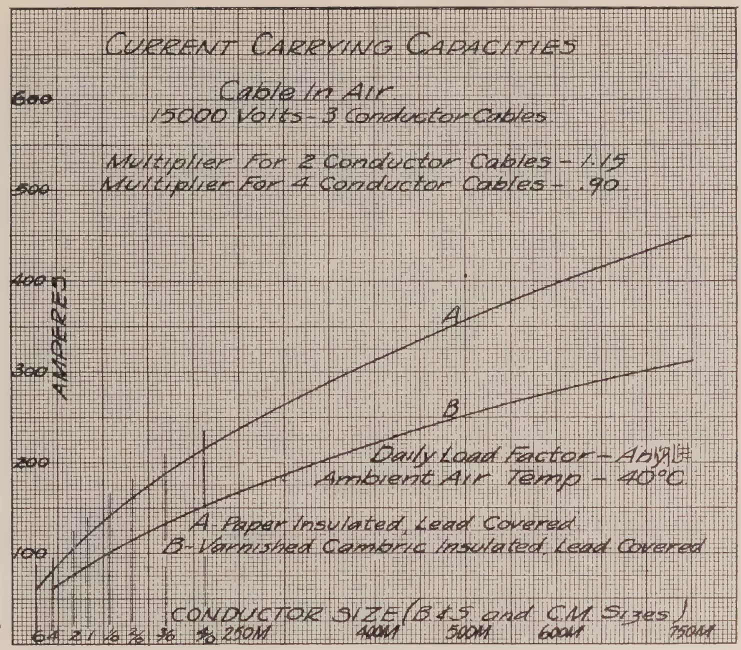

Graph No. 9




Graph No. 10




Graph No. 11

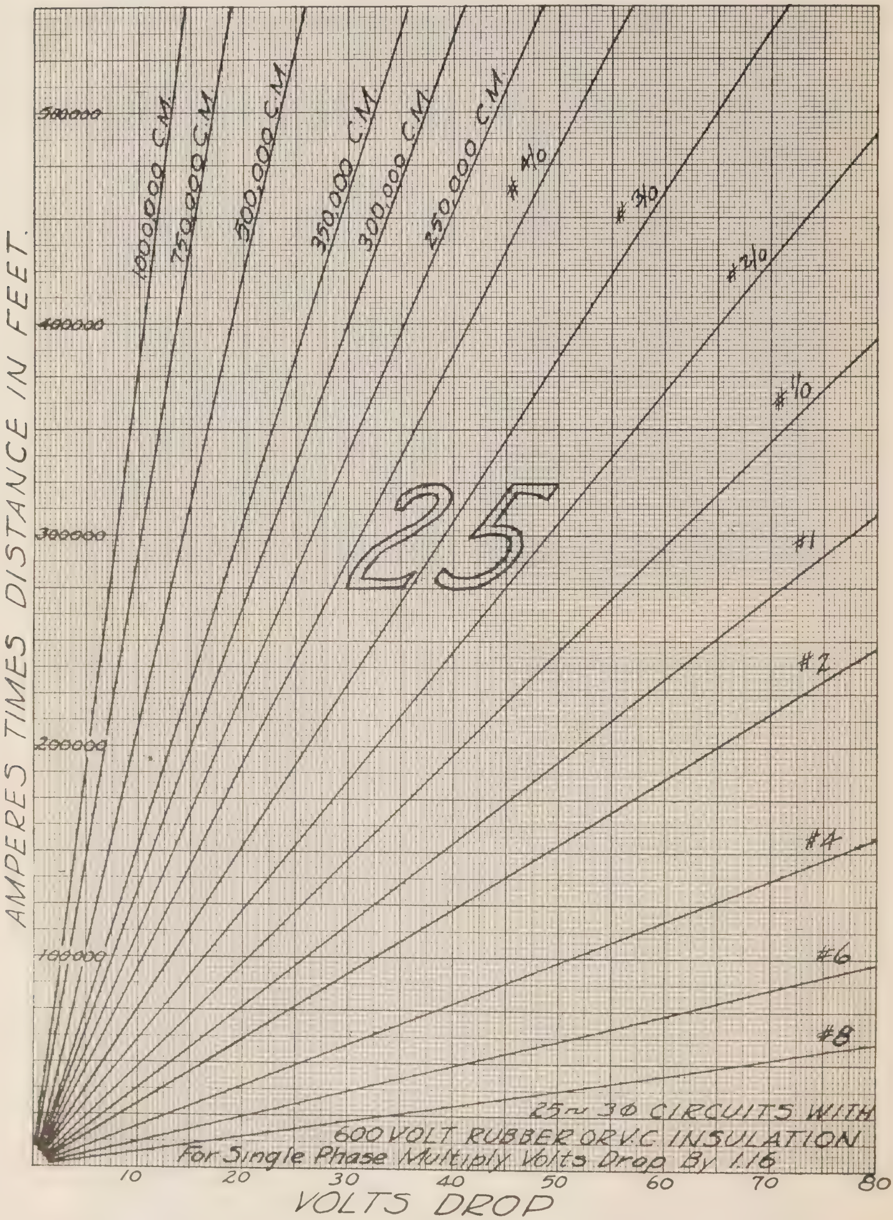



Graph No. 12

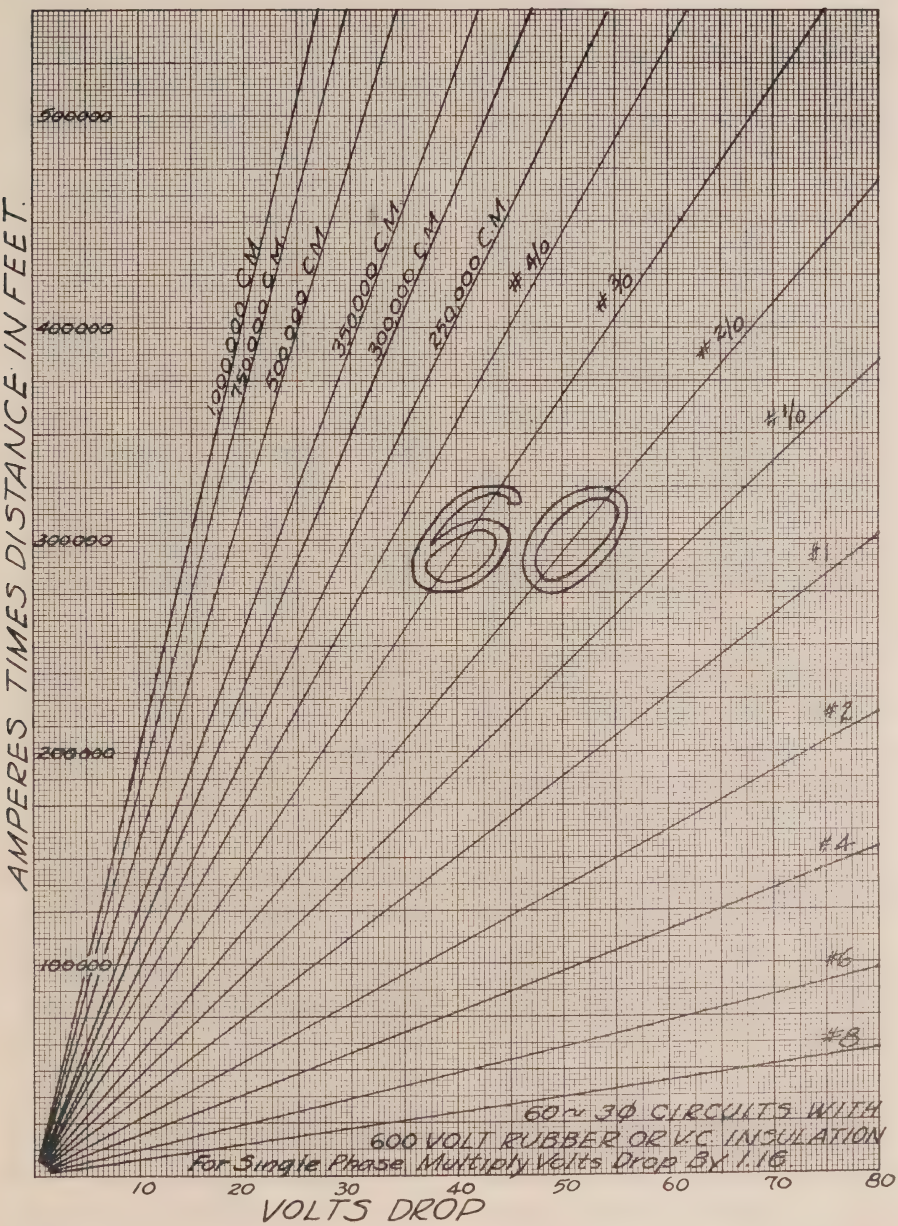
CORRECTION FACTORS for VARIOUS AMBIENT-AIR TEMPERATURES

| DEG. | | PAPER | | | V. C. | | | RUBBER | |
|---|---|---|---|---|---|---|---|---|---|
| °F. | °C. | 600v | 4500v | 15000v | 600v | 4500v | 15000v | 600v | 4500v |
| 68 | 20 | 1.20 | 1.20 | 1.25 | 1.29 | 1.29 | 1.53 | 1.41 | 1.41 |
| 86 | 30 | 1.11 | 1.11 | 1.13 | 1.15 | 1.15 | 1.29 | 1.22 | 1.22 |
| 104 | 40 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 122 | 50 | .88 | .88 | .85 | .84 | .81 | .58 | .71 | .71 |

APPLICABLE TO GRAPHS #10, #11, #12.


AMPERES TIMES DISTANCE IN FEET.
500000
400000
300000
200000
100000
1000,000 C.M.
750,000 C.M.
500,000 C.M.
350,000 C.M.
300,000 C.M.
250,000 C.M.
#4/0
#3/0
#2/0
#1/0
#1
#2
#4
#6
#8
25
25~ 3Φ CIRCUITS WITH
600 VOLT RUBBER OR V.C. INSULATION
For Single Phase Multiply Volts Drop By 1.16
10
20
30
40
50
60
70
80
VOLTS DROP

*Graph No. 13*


AMPERES TIMES DISTANCE IN FEET.
500000
400000
300000
200000
100000
1,000,000 C.M.
750,000 C.M.
500,000 C.M.
350,000 C.M.
300,000 C.M.
250,000 C.M.
#4/0
#3/0
#2/0
#1/0
#1
#2
#4
#6
#8
60
60~ 3Ø CIRCUITS WITH
600 VOLT RUBBER OR V.C. INSULATION
For Single Phase Multiply Volts Drop By 1.16
10
20
30
40
50
60
70
80
VOLTS DROP

*Graph No. 14*

# A.M.E.U. Winter Convention

IN the preceding issue of *The Bulletin,* and also in this number, the addresses and papers given at the winter convention of the Association of Municipal Electrical Utilities, are reproduced. This convention was held concurrently with Annual Meeting of the Ontario Municipal Electric Association, the attendance being about 500. Convention sessions were all well attended and there was a lively interest taken in all of the proceedings.

Following the report from the Committee on Accident Prevention and Health Promotion, a resolution was carried—"THAT the booklets *Recommendations for the Safe Operation of Electrical Properties* be distributed without charge to utilities paying into this Association; THAT such utilities as have already bought same to be refunded the amounts paid by them, and THAT the distribution of the booklets be left in the hands of the Committee on Accident Prevention and Health Promotion."

The Chairman of the Rates Committee advised of the Committee's having made a study of the Standard Interpretations of Rates and that suggested revisions had been submitted to the Hydro-Electric Power Commission of Ontario for consideration. The Secretary was instructed by a resolution to write the Hydro-Electric Power Commission of Ontario, asking if they can take early action on the proposed revision of the Standard Interpretations of Rates.

The report by the Committee on Accounting and Office Administration suggested that the system of Uniform Accounting should be taken under consideration for revision and the following resolution was adopted:

"THAT the Executive Committee of the A.M.E.U. be empowered to approach the Hydro-Electric Power Commission of Ontario, requesting them to have the system of *Uniform Accounting for Municipal Electrical Utilities,* compiled and issued by them in July, 1915, revised and brought up to date. THAT the Executive Committee also request that in the event of this work being delegated to a Committee, that this Committee consist of representatives of the Municipal Utilities as well as the Municipal Engineering and Municipal Accounting Departments of the Provincial Commission."

The discussion following the paper *Control Systems for Domestic Loads* brought out suggestions that it may be possible that other factors should be considered before the application of any of the systems described. The following resolution was therefore adopted:

"THAT the Hydro-Electric Power Commission be requested to make a report on the economics of controlling domestic loads as to the operation of flat-rate water heaters."

Officers elected for the year 1938 are as follows:

*President* — R. S. Reynolds, Chatham.

*Vice-President*—G. E. Chase, Bowmanville.

*Secretary* — S. R. A. Clement, H.E.P.C. of Ontario, Toronto.

*Treasurer*—S. E. Preston, H.E.P.C. of Ontario, Toronto.

*Directors (from the Membership at Large)*—A. B. Manson, Stratford; C. A. Walters, Napanee; P. B. Yates, St. Catharines.

*District Directors*—

*Niagara District* — A. W. Bradt, Hamilton.

*Central District*—W. G. Henderson, Cobourg.

*Georgian Bay District*—W. M. Salter, Barrie.

*Eastern District*—S. W. Canniff, Ottawa.

*Northern District* — C. J. Moors, Fort William.

The convention approved of the recommendation of the Executive Committee to hold the summer convention at Bigwin Inn on July 5th and 6th, 1938.

* * * *

At the meeting of the Executive Committee, held during the convention, the standing committees were drafted as follows:

*Papers Committee* — Messrs. H. F. Shearer, Welland, Chairman; V. A. McKillop, London; C. E. Schwenger, Toronto; R. L. Dobbin, Peterborough; R. M. Love, Canadian General Electric Company, Toronto; C. W. Hookway, Canadian Westinghouse Company, Toronto; G. A. Brace, Ferranti Electric, Toronto; G. J. Mickler and H. D. Rothwell, H.E.P.C. of Ontario, Toronto.

*Convention Committee*—Messrs. G. E. Chase, Bowmanville, Chairman; J. E. B. Phelps, Sarnia; W. R. Catton, Brantford; O. H. Scott, Belleville; C. C. Folger, Kingston; F. Mahoney, Canadian General Electric Company, Toronto; C. H. Hopper, Ferranti Electric, Toronto; E. G. McCracken, Sangamo Electric, Toronto; G. F. Drewry and B. Mulholland, H.E.P.C. of Ontario, Toronto.

*Regulations and Standards Committee* — Messrs. S. W. Canniff, Ottawa, Chairman; M. W. Rogers, Carleton Place; C. E. Brown, Meaford; F. W. Peasnell, Toronto; R. L. Dobbin, Peterborough; J. Eckersley, Toronto; W. P. Dobson, H.E.P.C. of Ontario, Toronto, and A. G. Hall, Electrical Inspection Department, Toronto.

*Committee on Accident Prevention and Health Promotion*—Messrs. P. B. Yates, St. Catharines, Chairman; J. E. B. Phelps, Sarnia; C. E. Schwenger, Toronto; J. W. Peart, St. Thomas; R. Harrison, Scarborough Township; V. A. McKillop, London; F. D. Hubbell, Windsor; R. L. Dobbin, Peterborough; R. J. Smith, Perth; A. B. Manson, Stratford; A. W. Murdock, B. Mulholland, V. A. Beacock, G. C. Parker and Wills Maclachlan, H.E.P.C. of Ontario, Toronto.

*Merchandising Committee*—Messrs. A. W. Bradt, Hamilton, Chairman; O. H. Scott, Belleville; F. S. Rhoads, Windsor; R. W. Turner, Hamilton; R. S. Reynolds, Chatham; H. R. Hatcher, Galt; A. W. J. Stewart, Toronto; O. C. Thal, Kitchener; H. F. Shearer, Welland; F. Wilkinson, London; E. Parsons, Sarnia; G. E. Chase,

Bowmanville; W. Dymond and G. J. Mickler, H.E.P.C. of Ontario, Toronto.

*Rates Committee* — Messrs. A. B. Manson, Stratford, Chairman; G. E. Chase, Bowmanville; P. B. Yates, St. Catharines; O. H. Scott, Belleville; O. M. Perry, Windsor; R. S. Reynolds, Chatham; T. R. C. Flint, and F. W. Peasnell, Toronto; W. R. Catton, Brantford; J. J. Jeffery, G. F. Drewry and S. R. A. Clement, H.E.P.C. of Ontario, Toronto.

*Committee on Accounting and Office Administration*—Messrs. W. G. Henderson, Cobourg, Chairman; George Appleton, Toronto, Vice-Chairman; T. W. Hutby, Welland; A. B. Manson, Stratford; J. A. Hammond, Hamilton; W. E. Wallace, Windsor; M. A. Gough, East York Township; J. W. Bayliss, Niagara Falls; R. S. King, Midland; W. M. Salter, Barrie; R. C. Parker, Penetanguishene; M. W. Rogers, Carleton Place; H. Clegg, Peterborough; A. D. Nelson, Kingston; W. E. Reesor, Lindsay, and R. M. Bond, H.E.P.C. of Ontario, Toronto.

*Auditors* — Messrs. H. P. L. Hillman, Toronto, and W. G. Pierdon, H.E.P.C. of Ontario, Toronto.

* * * *

# Report of the Committee on Accident Prevention and Health Promotion

The work of the Accident Prevention and Health Promotion Committee this last year has been confined to the work of issuing the regulations for the safe operation of utilities, based on the safety regulations of the Toronto Hydro-Electric System. It is a reprint, complete, of their regulations.

Word was sent to all the utilities that these books were available, and I think it would be to the advantage of all the systems if they would get copies of these books and study them. See if you can get your men to study them. See if you can get them to absorb what is in the book. If they will not do it of their own volition and you can't make them intelligently read them, the regulations are very good subjects to discuss at the weekly or bi-weekly or monthly accident prevention meetings of your staff.

I would suggest to those utilities that have not sent for these books, that they secure a number and see what can be done to overcome the accidents which continually raise our rates with the Workmen's Compensation Board.

In past years a system with a number of bad accidents just had hard luck, but it didn't cost them anything financially, because it was all distributed over the group; but now that we are assessed by the Workmen's Compensation Board on the merit system, it certainly does pay each Commission and each Manager to see that the accidents are minimized. It is a direct financial saving, and I think we should all work toward that end not only for economic reasons, but for the good of our employees, and I would suggest that all those who have not done so, send an order to Mr. Clement for a number of these books. They cost you 25 cents apiece. They cost us that much.

* * * *

# Report of the Committee on Accounting and Office Administration

A meeting was held under the direction of the Committee on Wednesday, February 3, 1937, in the Roof Garden, Royal York Hotel, Toronto. Some sixty-seven representatives from the municipalities sat down to breakfast with those from Head Office and several office equipment firms. After breakfast the meeting was addressed by Professor W. S. Ferguson, C.A., on "Progress in Accounting." The meeting adjourned at 10.30 a.m. to allow those present to attend other Convention sessions.

The Committee met on Wednesday, June 30, 1937, at 8 a.m. in the Rainbow Room of the General Brock Hotel, Niagara Falls, Ontario. Some fifty people sat down to breakfast and the meeting then convened to the Committee room with Mr. J. W. Bayliss of Niagara Falls, Ontario, in the chair. The following matters were discussed:—

(1) A system of Credit Rating for Municipal consumers was introduced by Mr. W. E. Wallace, of Windsor, and as the majority of those present gave approval to some such general scheme it was decided that a sub-committee be named to investigate the advisability of setting up some system of Credit Rating for consumers and to report with recommendations to the 1938 Winter Convention.

(2) Revision of Uniform Accounting Manual—Mr. M. A. Gough of East York introduced this subject and it was the consensus of opinion of those present that the Standing Committee should be empowered to take whatever action necessary to have the revision made.

(3) Sectional Meetings—The advisability of holding sectional meetings was introduced by the Secretary and the consensus of opinion was that as these meetings were exceedingly helpful the Standing Committee be authorized to sponsor the arrangements for any sectional meetings they deemed advisable between this date and the date of the Winter Convention, 1938.

The Standing Committee met in the afternoon of Tuesday, September 28, 1937, at 620 University Avenue, Toronto, and sub-committees were named in accordance with the instructions of the Niagara Falls Summer Convention.

A sectional meeting was arranged in accordance with the wishes of the general committee to be held in Windsor on Tuesday, 26th October, 1937, at 2 p.m. at the Prince Edward Hotel.

Plans for the Winter Convention were introduced and a program committee was named in respect thereto and permission was given the program committee to arrange for the following:—

(1) A Breakfast Meeting.

(2) A display of office equipment and records.

The program committee was asked if possible to set up the program to take the form of a round table method of discussion rather than to have a special speaker obtained.

In accordance with the instructions of the Standing Committee a sectional meeting was held in the Prince Edward Hotel, Windsor, on Tuesday, October 26, 1937, to which representatives from all municipalities on the Niagara System west of London were invited. Some sixty were in attendance and the afternoon was spent in considering the following items:

(1) A paper by Mr. F. A. Archer of the Municipal Accounting office, Toronto, on Billing Methods brought up-to-date.

(2) A paper presented by Mr. H. T. Macdonald of the Municipal Accounting office, Toronto, on the General Ledger with particular reference to the distribution of Expenditures, Capital Accounts and Reserve Accounts.

These papers brought about considerable discussion and the suggestions arising therefrom were of considerable interest and value to those present.

After the meeting adjourned a number of those present visited the offices of the Windsor Hydro Division and spent some time in looking over equipment and discussing methods in vogue in the Windsor office.

The Windsor Utilities Commission, Hydro Division, were hosts at a dinner at 6.30 p.m. to those in attendance at the afternoon session together with a number of invited guests and a most enjoyable evening was spent in that way. The speaker of the evening was Magistrate D. M. Brodie, of Windsor, and the chair was occupied by Mr. W. E. Wallace, of the Windsor Utilities Commission, Hydro Division.

* * * *

## Report of the Regulations and Standards Committee

The Regulations and Standards Committee hadn't a very strenuous duty to perform this year.

As you will remember, the Department of Trade and Commerce put out Departmental instructions to Meter Inspectors in June. This matter was taken up by the Committee, headed by Mr. Brown last year, but it was felt this year, as a result of a letter canvass to the members of the Committee, that it was not necessary to call a meeting to discuss these new regulations, but the subject matter of any discussion would more or less depend on any unforeseen difficulties that came up after these regulations were in use and practice for about a year. In talking to some of the members since—and I think this applies to the 25-cycle meters, more than to the 60-cycle meters—it was thought that the power factor requirements, included in the regulations were a little bit too drastic. I think that, again, will have to depend on practical experience.

# THE BULLETIN

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# "Controlling the Sale of Electrical Equipment in Ontario"

By H. J. McCaw, Electrical Inspection Dept., H.E.P.C. of Ont.

THE purpose of this paper is to describe what the Electrical Inspection Department is doing to enforce the Regulations regarding electrical equipment.

Most of you are familiar with the Rules and Regulations. Formerly, the Approvals Laboratory carried on the work of enforcing The Power Commission Act as well as the testing and inspection of electrical equipment. It was difficult for them to do this. They would have to deal with some offender, possibly take him to police court and afterwards test the equipment, if he made application for approval. You can see that, at times, it might be difficult to convince him that he was being treated fairly.

The inspectors have been unable to control the situation adequately, hence the appointment of a special inspector to devote his full-time to this work.

Paper presented at the Annual Convention, of the Ontario Electrical Contractors Association at Toronto, January 25, 1938.

In June, I was transferred from the Approvals Laboratory to the Electrical Inspection Department, under the supervision of Mr. A. G. Hall, to look after the sales control of electrical equipment and the enforcement of the Regulations.

The Approvals Laboratory and the Electrical Inspection Department work closely together. The Inspection Department receives full co-operation from the Approvals Laboratory. They provide information regarding applications for approval received, letter reports and final reports issued to manufacturers, approvals cancelled, equipment placed on the "List of Unapproved Material" and information they may receive from time to time regarding unapproved equipment found in the field.

At present, a considerable amount of unapproved equipment is being sold. It is found in various types of retail stores, importers, premium

## CONTENTS

**Vol. XXV** **No. 4**
**April, 1938**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

houses and small distributors. We also find that peddlers bring it from other provinces, chiefly from Quebec, but the bulk of this type of equipment comes in from the United States. Citizens also bring in all sorts of equipment from the United States under the $100.00 regulation.

One of the objects of the Electrical Inspection Department is to make a systematic check-up of all stores such as hardware, drug, furniture, radio, electrical, gift shops, as well as wholesales, importers, manufacturers, manufacturers' agents and possibly factories at times. We intend to see what they are selling, and to see that they handle approved equipment only. If we find them handling unapproved equipment, they will be warned and given a period of time to return it to their supplier. If they do not do so, information shall be laid against them in Police Court. If they are habitual offenders, they may not be warned. We do, however, want to handle the matter as nicely as possible, as it is not our intention to be arbitrary.

The Commission, some years ago, printed a small booklet with pages in duplicate which contained a warning reading as follows: "You are hereby .................................................. Act. The goods ..........................................................Act." There is a space in which the name of the questionable article may be written. This order form has been used in the years past with success, but recently we have not made use of it.

Up to the present time, a call has been made upon almost every store selling electrical equipment from Toronto to Windsor and as far north as Arthur and Kitchener. East of Toronto, no calls have been made. This territory, as well as the north, shall receive attention in the Spring and Summer of this year. In practically every instance, I have made myself known. There has been an odd case where the store people were busy and, after looking around, I decided that the equipment was satisfactory.

In addition to this, attention has been given to all equipment displayed at exhibitions, fall fairs, ploughing matches, gift shows, conventions, etc.

You may be interested in some of our experiences. The first sources of trouble were found to be portable

lamps. There were two or three offenders, and about the last of November we had a summons issued against one of them. After failing to serve him and finding that on the day he should have appeared in court in Kitchener he was selling more unapproved lamps in Hamilton, a second information was laid against him. He then realized we were catching up with him, so he made application for approval to the Commission. He was advised to accept his summons, and was fined in each city. This has reacted somewhat on other lamp dealers and importers. By the way, now we do not accept applications for approval until the court cases have been settled.

Another we had trouble with was the paper signs. Some manufacturers provided signs without any electrical equipment attached, but made all the necessary arrangements for the dealer to violate the Act. Even yet, a few of these are putting in an occasional appearance.

We have also run across unapproved cigar lighters. The ones referred to are the tumbler type, being part of a smoker set. They were found principally in furniture stores, and the salesmen advised the buyers that they were approved. They were sold by four firms working out of Montreal, and, for that reason, we could not prosecute them.

An appeal was made to the Chief Examiner of the Board of Examiners of Electricians, Province of Quebec, for his assistance. Several firms were fined in Montreal for having cigar lighters in their possession. As this type of merchandise is seasonal, we do not know whether we have this under control at present.

At Christmas time, the province was flooded with unapproved toy wood-burning pencils. A manufacturer had received the Commission's approval, and then he shipped substandard pencils. These were shipped from the United States. The manufacturer admitted they were substandard. Just for your information, let me say these were made for children. The joints within the handle were not taped, and, in addition to this, provision was not made for strain relief—thereby enabling the cord to be pulled out, thus exposing two live connections.

A manufacturer of heating pads constructed and sold a large quantity of substandard pads. They were sold to a chain of drug stores. The manufacturer was obliged to recall the pads and reconstruct them.

Lately we have had trouble with electrically-operated pin games, slot machines and other so-called gaming devices. We prosecuted and obtained a conviction in Toronto against one local distributor.

To show you that we are not too hard-boiled, we found a firm had shipped out a large number of unapproved signs. After the shipment had been made, we found the signs all over the country. The manufacturer had made the signs for someone else, each thinking the other would have them approved. A representative sample was submitted to the Approvals Laboratory and accepted without alterations. We told the manufacturer that the signs that were out had to be labelled. He could take one of

the inspectors along with him in Toronto and label the signs in his presence.

For those out of town, we are asking them to supply us with a list of locations where the signs have been sent. We will have our inspectors label these signs in their districts at their convenience. This we are doing gratis.

We did not advise the manufacturer of our intention to do this at first, and he was somewhat worried in case he might have to take an inspector all around the country to label the signs.

We run into all sorts of incidents in calling upon stores. Sometimes we find equipment that has not been made for years. We have found substandard equipment such as wire, small accessories, fittings, 250-watt sockets, some Japanese bulbs, tape, etc.

We found one dealer did not like to have the manufacturer's name on the Combination Approval Label. He was warned against defacement of labels.

We find that the storekeeper appreciates Hydro approval. If he is told the equipment is not right, he does not want it. In making our inspections of stores, we have been made welcome in practically every instance. Possibly the fact that the housewife is becoming conscious of Hydro approval helps some.

In relating these incidents, such as the first one, you will note we are receiving co-operation of the Board of Electrical Examiners in Quebec. We work very closely with them, each keeping the other posted with troubles encountered. If it were not for this, some of the offenders from that province would be hard to deal with, as we cannot prosecute outside of the Province of Ontario.

The Approvals Laboratory send a weekly bulletin to the provincial inspectors in Canada containing a list of applications received from manufacturers, final reports completed and material placed on the list of unapproved equipment. This is the same bulletin as sent to our own inspectors.

This is something that interests the contracting trade probably more than some of the afore-mentioned. Lately we have been checking closely the installation of machinery in factories, shops, etc. Our inspectors are doing a good job in reporting new equipment found in these places. We are pressing them to report every installation.

If, therefore, we withhold a permit on the contractor because of unapproved equipment installed, it hurts him. You will be helping yourself, the manufacturer and the Commission if you advise the firm for whom you may contract to work that any equipment you install must be of an approved type. It is only fair to manufacturers of approved equipment that they be on equal footing with others. The Commission's Rules and Regulations apply to all without discrimination. One manufacturer is not asked to do anything another would not be asked to do.

Your attention is called to approved equipment which is required to be labelled, such as blowers and stokers. If labels do not appear, do not install them.

Again for your information: The Electrical Inspection Department intends putting out a small instruction sheet which will interpret rules, keep you posted on any changes in rules and give you information regarding them. It will be issued at least about every two months. A mailing list is being compiled at the district offices and also here in Toronto. Your name should appear on the list. This pamphlet will not be for the electricians themselves.

In conclusion, gentlemen, if you, as contractors, have any complaints to make to us, do not hesitate to do so. We can iron them out to our mutual advantage.

I trust I have given you some information as to what is being done in controlling the sale of electrical equipment in this province. We are not trying to act arbitrarily in enforcing the Regulations. We are asking for your co-operation. If this is received, it will be pleasant for all of us.

# Convention Questionnaire

*(Continued from March)*

14. The present standard for street lighting consists of a gooseneck bracket, radial wave reflector, and 100-watt multiple lamp, or similar series lamp. The efficiency of this outfit is low. How can this best be modernized to give a proper light distribution curve, and at what expense?

*Mr. R. S. Reynolds, Chatham:* In regard to this question, there is not very much you can say on it.

I have made enquiries of various companies as to what might be done, and they, more or less, threw up their hands because when it comes to increasing the efficiency of the present radial type reflector, it is almost impossible. I know from experience in our own municipality and looking around in other places, through which I have passed, that you might increase the efficiency a lot by a little cleaning of the enamelled reflector, or replacing some of these reflectors that are very badly chipped or rusted through the enamel and I think that this could be carried out. But an actual method of modernizing to give a proper distribution of light, is something about which we can do very little.

The cheapest method of helping out the difficulty of keeping the light down on the ground level, is adding some type of attachment to the present shade or there are types of shades manufactured to-day in various curves and forms and the makers claim that these help out the light distribution to a great extent.

However, I think that the proper way of helping out the distribution curve in these overhead reflectors is to try and convince the utilities to buy some of the newer types of over-

head street lighting units, wherein the bulb itself is set up into a type of reflector or refractor with a glass base on it, so built that the light may be distributed as you see fit. In this way, corner lights could have a four-way distribution and the ordinary type a two-way distribution along the street. I am not prepared to say what expense this involves as some places have a great number of lights and they are placed in locations differently in each city.

*Mr. M. B. Hastings, Powerlite Devices, Toronto:* I was quite interested in Mr. Reynolds' remarks about cleaning porcelain enamelled radial wave reflectors.

We have been trying to sell the idea of new reflectors to replace the chipped and rusted reflectors which have been in use for a great many years, but have not been successful.

It is a good idea to have a routine reflector cleaning schedule, the same as you have for glassware cleaning.

Reviewing the question, I don't think it was intended to convey the idea the gooseneck was the Hydro standard of lighting. That is obviously not the Hydro standard, because wherever you go, you see much better standards of lighting than could possibly be obtained by what is commonly known as the "gooseneck" bracket and reflector. However, it is used quite extensively and undoubtedly has a place on certain residential streets.

You all know of the Street Lighting Committee, which is a very important Committee in the Illuminating Engineering Society. This Street Lighting Committee consists of nine manufacturers and 18 who are not manufacturers. The personnel of this Committee is as follows:

1 University Professor,

1 From the National Bureau of Standard and Testing Laboratories,

3 Traffic Engineers,

5 Central Station Engineers,

3 Independent Consulting Engineers,

1 Casualty Underwriter,

9 Manufacturing Engineers,

4 Municipal Engineers from four different sections of the North American Continent.

A brief description of some of the rules which are suggested by this Committee might be in order, and I suggest Mr. R. M. Love, who is a Past Director of the Illuminating Engineering Society, might give some valuable information on this Committee.

In my opinion, the answer to the question would be as follows:

It is not economical to try to modernize any of the existing installations of gooseneck brackets and radial wave reflectors.

*Mr. R. M. Love, Canadian General Electric, Toronto:* A few years ago street lighting recommendations were made as a particular engineer or manufacturer's representative thought it should be. To-day we have the Illuminating Engineering Society code of street lighting, and a partial study of this code will go a long way toward answering this questionnaire.

Street lighting should be primarily considered from a volume of traffic standpoint and the standard that is referred to in the questionnaire, the

gooseneck and radial wave reflector, does have a place in the code, but does not in any way meet the requirements other than a street classification which carries practically no through traffic.

To briefly mention the requirement of the code, we would point out that it is divided into residence streets or non-thoroughfares, and thoroughfares which are then divided into light traffic, medium traffic and heavy traffic thoroughfares. Light traffic thoroughfares have a volume under 500 vehicles per hour in both directions, medium traffic thoroughfares 800 vehicles per hour in both directions, and heavy traffic is 1,500 vehicles or more per hour in both directions.

As to the minimum requirements, first let us look at non-residence streets or non-thoroughfares. The code recommends spacing 50 to 200 ft. staggered, minimum size of lamp 2,500 lumens, or 150-watt multiple lamps, this being 2,535 lumens when burned at normal voltage. Mounting height is 18 ft. to light centre, and the minimum with the light centre located beyond the curb. This point is of the utmost importance.

As an alternative on residential streets, which are non-thoroughfares, the luminaires can be spaced 100 to 125 ft., using 1,000 lumen lamps or a 75-watt multiple lamp burning at 100 per cent. voltage, with a mounting height of a minimum of 15 ft. and again the light centre located over the roadway beyond the curb.

The suspension units used should not be less than 25 ft. At intersections, in all cases, it is recommended where bracket units are used that two units be installed diagonally across at the intersection.

On thoroughfares with light traffic, the minimum size lamp is 4,000 lumens. Here the minimum mounting height is 18 ft. and again the light centre recommended beyond the curb.

For medium traffic thoroughfares, the 10,000 lumen lamp, or 500 watts, is recommended at a spacing of 150 ft. staggered, with the light centre beyond the curb. In heavy traffic arteries, the code recommends the spacing to be 150 ft. opposite, with a minimum light centre of 18 ft., but preferably 20 to 30 ft., again using 10,000 lumen or 500-watt lamps, and again very definitely recommending the light centre to be beyond the curb.

This really is a standard for street lighting and it isn't the size of any city or town that determines the size of lamps, spacing or type of equipment. It is the volume of traffic that determines actually what lighting should be installed.

All these recommendations, of course, are based on the use of the most efficient equipment available, and within the last few years the manufacturers have greatly improved the efficiency of street lighting equipment.

I believe Mr. Mudgett is going to say a few words in regard to this questionnaire, and he will add to these remarks and give you data as to the efficiency of modern equipment and what is available to-day.

*Mr. G. F. Mudgett, Canadian Westinghouse, Hamilton:* In order to arrive at an answer to this question, I have

made a brief study of the cost and utilization factors of the present type of radial wave reflectors as compared with the cost and utilization factors of the more effective asymmetric radial wave reflectors, particularly of the ALZAK reflecting type.

In the first place, the utilization factor of the present radial wave reflector is extremely low, as we know. However, if we replace that type of reflector with an asymmetric radial wave reflector of the ALZAK type, we can deliver 50 per cent. more lumens on the street and the cost of doing that will be increased approximately 50 to 60 per cent.

Mr. Love has referred to the I.E.S. Code of Street Lighting, which we must not overlook, because this code specifies a minimum lamp size of 1,000 lumens only for non-thoroughfare residential streets and that the lamps should be used on 100 to 125 foot staggered spacing, at a minimum mounting height of 15 feet. The code further specifies that at intersections at least two 2,500 lumen or one 4,000 lumen lamp should be used.

On the basis of the present Hydro standard for street lighting, by using a 100-watt lamp on 100-foot spacing, we obtain approximately 13 lumens per lineal foot of street, whereas the I.E.S. code specifies a minimum of 8 lumens per lineal foot. Therefore, as far as the non-thoroughfare residential street is concerned, the Hydro standard is better than the I.E.S. code. However, as soon as we leave the non-thoroughfare residential street and get into traffic thoroughfares carrying a minimum of 500 vehicles per hour, we find the Hydro standard is actually sub-standard because the I.E.S. requirements are actually about 27 lumens per lineal foot of street.

Mr. Love pointed out, and I had the same thought, it must be noted from the I.E.S. code that all their recommendations are based on the use of the most effective equipment in the most effective manner.

Now, reverting to the radial wave type of reflector again, I mentioned we could obtain 50 per cent. improvement or 50 per cent. more lumens on the street. However, we must consider that with the present type of reflector, we are only obtaining about 12 per cent. utilization factor and if we increase 50 per cent., we only obtain 18 per cent. utilization and we are still too low from the standpoint of using the most effective equipment in the most effective manner.

At the present time, we have available lighting units of the refractor and reflector type, which increase the utilization factor as much as 200 per cent. or more. In other words, by using more effective equipment, we can step up the utilization factor very materially and increase it to at least 40 per cent.

These lighting units I refer to, use much larger lamps than we are generally accustomed to use, that is, speaking of 100 watt or 1,000 lumen lamps, as compared to lamps rated at 500 watts or 10,000 lumens. Consequently, fewer units can be used and the cost of illumination would not be increased as we might assume because it is more economical to use a small number of large lamps than it is to use a large

number of small lamps. The use of large lamps in modern lighting units when properly applied, results in delivering the maximum in effective lumens on the street surface.

* * * *

15. Would there be any advantage in billing the municipalities for street lighting on a lumen basis rather than for candlepower and watts?

*Mr. G. G. Cousins, H.E.P.C. Laboratories:* The cost of power is a basic charge because power is paid for and converted into light. Lumens are paid for in terms of the watts that are consumed in their production. It, therefore, seems logical to rate lamps in watts, as this will be a constant quantity for any given size of lamp. The lumens produced may vary from time to time, but the amount of the power used will remain unchanged. Any change in lumens for any one type of lamp will not produce a noticeable change in the intensity of illumination. It seems evident from this that lamps rated in watts furnish the simplest and most direct method of charging for the lamps' part of the operating cost. Multiple lamps are rated on the watts basis.

*Series Lamps*

The present rating of series lamps is a relic of arc lamp days. Arc lamps were rated in candle power, because there was no convenient nor satisfactory method of measuring lumens. Consequently, street lighting contracts were based upon the candle power ratings of the arc lamps that were used. In a great many instances, such contracts were in force when incandescent filament lamps were introduced and in order to comply with the terms of the contracts, the new incandescent lamps were rated on a similar basis. With the development of gas-filled tungsten lamps with coiled filaments, there was a variety in the ways in which the filaments were formed and mounted in the bulbs, with the result that the candle power did not accurately represent the light-giving power of the lamps and for engineering purposes, the light-output was measured and expressed in terms of lumens. Still, contracts stipulating lamps of definite candle power values must be complied with and many of the men associated with this work were not familiar with any but the candle power rating. This difficulty was overcome by adopting a nominal relationship between the candle power and lumens, the candle power rating being 1/10 of the lumen rating; 100 candle power corresponds to 1,000 lumens.

When the Commission's engineers, in 1913 or 1914, drew up specifications for series lamps, the wattage rating was adopted for the reason that there would be a simple relation between the capacity of transformers and the number of lamps that could be supplied by them. This worked well for several years, but with Hydro lamps rated in watts and other brands in candle power and lumens and both kinds used in one town, the auditing department ran into difficulties in trying to allocate charges for lamps of one basis of rating when the rates were based upon the other method of rating. So much confusion resulted from this that the rating of Hydro

series lamps was changed from the watts to the candle power-lumen basis.

The wattage rating possesses advantages over the candle power-lumen rating, but the only known reason for the retention of the latter is that it has become thoroughly established throughout America and there are possibly still some old contracts in force which are based upon the candle power method of rating the lamps.

* * * *

16. How can the rural Hydro drop their service charge from $2.50 to $1.00 in a few years without a loss?

*Mr. R. T. Jeffery, H.E.P.C. of Ont., Toronto:* The service charge in Rural Power Districts cannot be reduced from a maximum service charge of $2.50 to a maximum service charge of $1.00 for Class 3 Rural Consumers without increasing the loss on account of Service Charge in all Rural Power Districts.

Who pays for the loss, if any?

*Mr. Jeffery:* The Rural Power District Service Charge Act provides for advances from the Consolidated Revenue Fund of the Province to meet losses that may be incurred by Rural Power Districts on account of supplying service to various classes of consumers where the service charge is insufficient to meet the actual cost of such service charge. The amount of the losses advanced to such Rural Power Districts is to be returned to the Consolidated Revenue Fund by these various Rural Power Districts, if, as and when in future years, the surplus on service charge in these districts is sufficient to result in a surplus sufficient to repay all or part of such advance.

Are the urban municipalities paying for some of the loss in a way unknown to them?

*Mr. Jeffery:* No part of the losses on Rural Power Districts is charged, in any way, to the urban municipalities.

# Birds' Nest in a Transformer

THE accompanying illustrations are from photographs of a service transformer removed for repairs from one of the Hydro systems. At the time it was taken out, it had been giving continuous service and no trouble, and to outward appearances had only a broken primary bushing. On opening the transformer it was found that birds had entered it through the bushing opening and built their nest as shown.

*Fig. 1—Transformer with cover removed, showing broken bushing.*

*Fig. 2—Looking into top of transformer, showing birds' nest.*

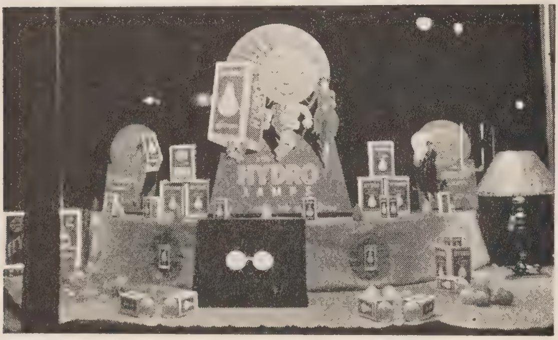
*Fig. 3—Nest being removed from transformer.*

*Fig. 4—Top of transformer after major portion of nest had been removed.*

# Hydro Lamp Window Dressing Contest Awards

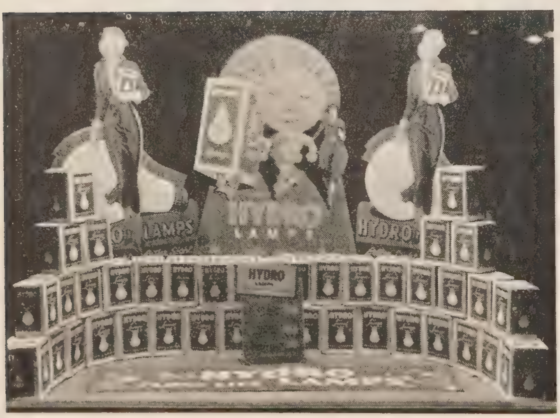
## Class 4

The Class 4 awards in the 1937 annual Hydro Lamp Window Dressing Contest, shown herewith, represents the creative efforts of Hydro Shops located in the smaller towns and in most cases it represents the efforts of those members of the staff whose other duties afford them little time for such display effort. However, the efforts were well worth while and had much to do with the increasing sale of the product displayed.



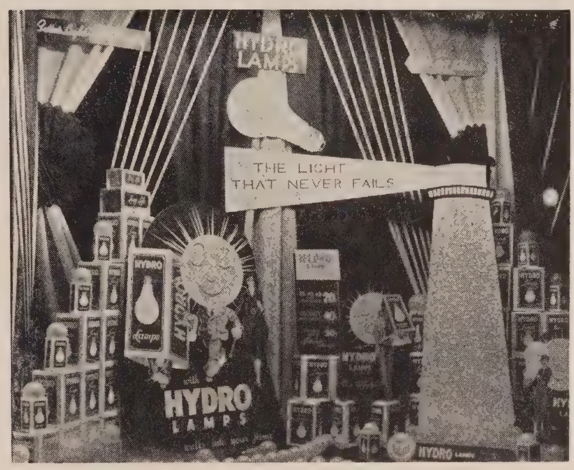

*Left—First Prize, Napanee Public Utilities Commission.*

*Above — Tie Second Prize, Class 4, Port Colborne Hydro - Electric Commission.*




*Left—Tie Second Prize, Class 4, Brighton Hydro-Electric Commission.*

*Right—Tie Third Prize, Exeter Public Utilities Commission.*




*Below—Tie Third Prize, Forest Public Utilities Commission.*


*Right—Tie Third Prize, Penetanguishene Water and Light Commission.*

*Below—Tie Third Prize, Glencoe Hydro-Electric Commission.*

# ANNOUNCING

## THE OPENING OF THE

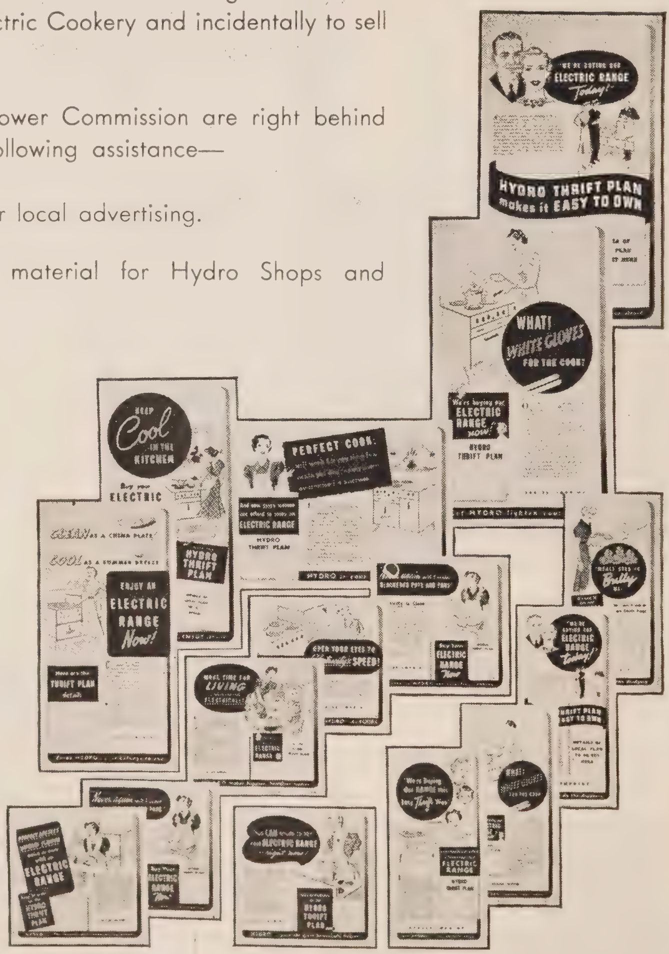
# 1938 ELECTRIC RANGE CAMPAIGN

## APRIL 15th, 1938

Every Municipality in the Province should get behind this effort to promote Electric Cookery and incidentally to sell more Hydro Power.

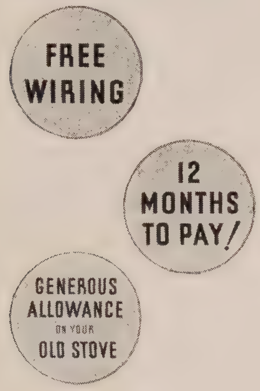
The Hydro-Electric Power Commission are right behind you and offer the following assistance—

- Mats and Cuts for local advertising.
- Window display material for Hydro Shops and Dealers.
- Special advertising allowance of $3.00 to Dealers on each new Electric Range sold.
- Educational matter on Electric Cooking for local newspapers.
- Displaying Electric Ranges in Rural Offices.
- Advertising Ranges to Rural Customers.




Display of Newspaper Ads for which Mats and Cuts are available Free.

- Sponsoring the "Cooking School of the Air".
- Organizing an ELECTRIC RANGE WEEK in as many Municipalities as will co-operate.
- Doing everything possible to help the Electrical Industry and Hydro Municipalities promote the use of Hydro.




We solicit the co-operation of all Hydro Municipalities to help one another in this Campaign.

HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO


Display of Show Cards available for Hydro Municipalities and Dealers Free.

# Hydro-Bell Agreement for Joint Use of Poles

By S. K. Cheney, Assistant Engineer, Distribution Section,
Electrical Engineering Department, H.E.P.C. of Ont.

*(Presented to the Association of Municipal Electrical Utilities at Toronto, February 9, 1938)*

THIS paper has been prepared with the object of explaining some of the features in connection with the operation of the agreement recently approved for use between the Bell Telephone Company of Canada and Municipalities served by the Hydro-Electric Power Commission. It is not the intention at this time to put forth any arguments either for or against joint use of poles for power and communication circuits, but to discuss only certain matters which should be understood and which should receive consideration before joint use is decided upon.

A few years ago it was recognized that a certain amount of joint use of poles was inevitable and that there was no agreement in force that was satisfactory in all respects. It was felt that there was need of a standard agreement acceptable to both parties which would adequately protect the interests of both and would set out clearly the terms upon which the occupancy of one party's poles by another could be made.

In joint occupancy of poles, it is necessary that the tenant have definite assurance of his rights for a set term; the tenant should be assured during this term, of proper maintenance of the supporting structures and freedom from encroachment by or hazard from the equipment of the owner. The owner of the pole must be assured of a fair revenue for the space made available and similar freedom from encroachment or hazard.

Most essential, however, is the need for clauses, clearly defined, fixing the responsibility in case of accident involving employees or plant of the parties to the agreement or other persons or property.

A joint committee, composed of representatives of the Bell Telephone Company and the Hydro-Electric Power Commission of Ontario was appointed to prepare an agreement with accompanying specifications.

The agreement now in your hands is the result of the prolonged study of this joint committee. It has been approved officially for use in Hydro Municipalities. Dealing with matters that are extremely contentious, it can hardly be expected that the agreement now offered will be found flawless. Criticism will be received gratefully, particularly after experience gained in its operation. There will be points arise that are not fully covered by the agreement, and methods of construction may be evolved that are preferable to those outlined in the specifications, and so provision is made

in the agreement to have the text reviewed at stated periods.

It is not the intention to go into every article of the agreement and specifications, as for the most part these are clear enough. It is desired to go into, rather, the operation of the agreement and to emphasize certain points, in the specifications, which are of especial importance.

It should be noted that, since under practically every agreement, each party will be both owner and tenant, any provision of the agreement will apply equally to both parties.

The reference to articles in the following refers to the articles in the approved agreement. The reference to illustrations 1 and 2 refers to the illustrations included with this paper.

In the past, in some cases, agreements have been entered into on a joint ownership basis, where each party owns one-half of each and every pole. While this may work out satisfactorily in certain cases, it is not recommended for general use. The approved agreement has been drawn up on the owner and tenant basis.

When two parties have decided to enter into a joint use agreement, there are two points that must be settled before the agreement is signed.

(a) *Rental.*

There are two bases of rental set out in the agreement, namely, "Space rental" and "Attachment rental."

Under the space rental arrangement, there is reserved, on the "standard pole" (a term which is described hereinafter), a definite space for the use of each party, within the limits of which may be placed such attachments as are required for rendering the service of the utility. This form of rental arrangement has certain advantages over other forms in the case of municipalities and requires a minimum of accounting detail, in that it obviates the necessity for a periodic count of individual attachments on every pole. The rental rates are determined by the height of the pole chosen for the "standard pole." The following rental rates have been adopted as representing one-half the annual carrying charges on a pole and are recommended for adoption on a space rental basis.

| Standard Pole | Rental Per Pole Per Year |
|---|---|
| 25 ft. | $1.25 |
| 30 ft. | 1.70 |
| 35 ft. | 2.20 |
| 40 ft. | 2.60 |

The Bell Telephone Co. and the H.E.P.C. made separate surveys to determine the total annual charges on poles and the results agreed very closely. The figure used in calculating the rental rates was of the order of 15 per cent.

It should be noted particularly that the maintenance above includes the cost of tree trimming, and as noted later, the owner of the pole bears the cost of tree trimming for both parties.

In arriving at the rental rate, an installed cost of $30.00 was used for the 35-ft. pole. This may appear somewhat on the high side, but if a fairly even balance of ownership is maintained, the actual rental rate is of small account.

The type of construction required for economical service in sparsely settled rural districts is quite different from that required for urban service, and this has made it desirable to use

a different rental arrangement for joint use in such locations. This arrangement is known as "Attachment Rental," and is designed for use between the Hydro-Electric Power Commission of Ontario and the Bell Telephone Co. to cover joint use between rural power lines or the telephone lines associated with the high tension network and the lines of the Bell Telephone Co. Due to the complexities which would arise in its application within built-up areas, the attachmment rental basis is not recommended for use in municipalities.

(b) *Standard Pole.*

On page two of the agreement there is a blank space to be filled in with the height of the standard pole. The term "standard pole" has reference only to a height of pole chosen for rental and accounting purposes. Of course, poles of greater and lesser height may be required also. For example, if the 35-ft pole is chosen as the standard pole and if on a certain street, it is found that a 30-ft. line of poles will be sufficient, the rental will be $2.20 per pole per year, which is the rental for a 35-ft. pole. The same applies for poles higher than standard.

Also, the choice of the standard pole sets the maximum height that the owner can be asked by the tenant to install without extra payment by the latter. Aricle "VII," section "f" sets out very clearly the division of costs for poles higher than standard.

Usually it will be found that if any extra height of poles is required, it will be by the power company, so that it is to the interest of the latter to see that the standard pole is not too short.

A 35-ft. pole allows for the power attachments five feet of vertical space and the telephone two feet, the remainder being space common to both parties. This will provide space for a crossarm and four wire secondary for the power and a cable or one crossarm for the telephone. This is about the average condition met in construction on urban streets.

It is thought that the 35-ft. pole is the height of pole to be adopted as the standard pole. In most cases, it will not be possible to mount a transformer on a joint 35-ft. pole and these cases will require five feet extra height, for which the power utility will have to pay.

There are several points in connection with height of poles that require special consideration in planning a joint line.

(1) If the poles are 35 ft. in height, care should be taken to provide 40-ft. poles at probable transformer locations. They cannot always be predicted, but a little care on this point will result in considerable saving in the future. If a standard pole has been placed initially in setting up the joint use and the tenant desires to have the pole changed to meet the requirements of his service, he must then bear the expense of the change, including the cost of the sacrificed life of the existing pole, but not any cost of the new pole unless his requirements are such that they necessitate a pole taller than standard.

(2) In some cases in which, for example, the standard pole is 35 ft., it may appear that a shorter pole will suffice for the requirements of both parties. If so, it will be advan-

tageous, from the viewpoint of economy and appearance, to use the shorter pole. If this is used, and the tenant, at a later date, requests that the shorter pole be replaced with a 35-ft. pole, due to an increase in his space requirements, how should the cost of the change be cared for?

(a) The agreement in article VII, paragraph (f) states that the cost of placing all poles up to the height of the standard pole, shall be borne by the owner and in article VI (b) provides for the tenant paying the owner's transfer and re-arrangement costs. This is a reasonable basis of settlement in those cases in which the owner installed the pole originally as a joint pole and, to the best of his and the tenant's knowledge, it appeared that a shorter pole would suffice, inasmuch as the owner has had a financial advantage due to the use of the shorter pole.

(b) If joint use had been entered into on an existing pole shorter than standard and the tenant at that time had not paid any residual value or re-arrangement expense to the owner, then it would appear reasonable that the tenant, at the time his requirements make a change necessary to a higher pole, should pay the residual value of the pole replaced and the owner's transfer costs, but not any cost of the new pole unless his requirements are such that they necessitate a pole taller than standard.

Having decided on the basis of rental and the standard pole, there will not be any difficulty filling in the remaining blanks in the agreement. The territory covered by the agreement should in most cases be limited to the corporate limits of the municipality.

The dates under articles XIV and XVI might be left to the discretion of the Bell Telephone Company, as they are dealing with a great many different municipalities, and it is advantageous to them to have the adjustment dates staggered over the year.

Under article XVIII, it is necessary to designate some party or parties to sign permits under the agreement. Such parties should be designated by their official titles, rather than by personal names.

The signing of the agreement does not give either party the right to make attachments to poles of the other party. When one party desires to make attachments to the poles of the other party, it will be necessary to fill out two copies of the Permit Form shown as Exhibit "C." On this form should be shown on a sketch the location of the poles and the amount of space required. If the party owning the poles is agreeable to the application, he will sign the Permit Form and return one copy to the applicant.

If the poles are suitable for joint use without any change, the applicant may place his attachments on the poles specified and pay rental from that date.

If, however, any or all of the poles are not suitable for joint use, or if any of the owner's attachments have to be re-arranged to make provision for the applicant, the following arrangements are to be followed

(1) The applicant will pay to the owner a sum equal to the then value

in place of any poles that have to be changed.

(2) The applicant will pay for any extra height of poles, as set out in article VII.

(3) The applicant will pay the labor cost incurred by the owner in transferring his attachments from the old poles to the new or for any re-arrangements that may be required on poles that are suitable. Unless otherwise arranged, each party shall bear the cost of any material used in its own plant.

(4) The owner will install the new pole and remove the old pole at his own expense, retaining ownership of the old pole in lieu of the cost of removal. It is expected that, on the average, the salvage value of the old pole will not exceed the cost of removing same.

(5) The applicant shall commence paying rental from the date the space is made available, even though his attachments are not placed on the poles till a later date.

As it is recognized that it is sometimes difficult to arrive at a value of a pole that has been in place for some time, below is given a method for use in this connection. The use of this information is, of course, not compulsory, but is given here for your guidance.

The Bell Telephone Company has prepared from their mortality records a table, showing the residual value of poles, depending on their age. The figures used are the average cost for a large number of municipalities. They may appear high for some of the smaller municipalities, but as they would be applied to replaced poles of both parties, the actual value used is of less importance. This table (table 1) is included in this paper, with the permission of the officials of the Bell Telephone Company. The figures in the table show the original cost, less the amount set up in renewal reserves. By the use of this table or a similar one, the owner of the pole is enabled to wipe out his original capital in the pole which is replaced. The table is based on an average life of 21 years. In order to get an average life of 21 years, it is necessary that a number of the poles have a life in excess of 21 years. For this reason, a pole that is still in service after 21 years is assumed to have some residual value, for example, a 35-ft. pole, 21 years old, has a residual value of $7.38, according to the table.

If the age of the pole is known, it is necessary only to look up in table 1 the residual value of a pole of that height and age.

In many cases, the age of the pole is not known. For such cases, table 2 has been prepared, and this table may be used in the following manner:

An estimate is made of the remaining useful life of the pole under consideration, based on its physical conditions and the load it is carrying.

Referring to table 2, the equivalent age of this pole may be obtained by looking up the age of the pole that has the same average remaining life as the pole under consideration.

This equivalent age may then be used in conjunction with table 1 to arrive at a residual value.

## TABLE 1

### JOINT USE ON A SPACE RENTAL BASIS
### VALUE OF SACRIFICED LIFE OF POLES DISPLACED—(BASED ON 21 YEAR LIFE)*
### CLASS "B" POLES
### LICENSOR RETAINS POLE
### VALUE OF SACRIFICED LIFE

| Year of Age | % Condition | 25-ft Unit Cost | 30-ft. Unit Cost | 35-ft. Unit Cost | 40-ft. Unit Cost | 45-ft. Unit Cost | 50-ft. Unit Cost |
|---|---|---|---|---|---|---|---|
| 0 | 100. | $16.96 | $22.35 | $28.61 | $33.81 | $41.09 | $48.23 |
| 1 | 95.3 | 16.16 | 21.30 | 27.26 | 32.22 | 39.16 | 45.96 |
| 2 | 90.8 | 15.40 | 20.29 | 25.98 | 30.70 | 37.31 | 43.79 |
| 3 | 86.2 | 14.62 | 19.27 | 24.66 | 29.14 | 35.42 | 41.57 |
| 4 | 81.8 | 13.87 | 18.28 | 23.40 | 27.66 | 33.61 | 39.45 |
| 5 | 77.5 | 13.14 | 17.32 | 22.17 | 26.20 | 31.84 | 37.38 |
| 6 | 73.2 | 12.41 | 16.36 | 20.94 | 24.75 | 30.08 | 35.30 |
| 7 | 69.2 | 11.74 | 15.47 | 19.80 | 23.40 | 28.43 | 33.38 |
| 8 | 65.1 | 11.04 | 14.55 | 18.62 | 22.01 | 26.75 | 31.40 |
| 9 | 61.2 | 10.38 | 13.68 | 17.51 | 20.69 | 25.15 | 29.52 |
| 10 | 57.4 | 9.74 | 12.83 | 16.42 | 19.41 | 23.59 | 27.68 |
| 11 | 54.0 | 9.16 | 12.07 | 15.45 | 18.26 | 22.19 | 26.04 |
| 12 | 50.4 | 8.55 | 11.26 | 14.42 | 17.04 | 20.71 | 24.31 |
| 13 | 47.2 | 8.00 | 10.55 | 13.50 | 15.96 | 19.39 | 22.76 |
| 14 | 44.0 | 7.46 | 9.83 | 12.59 | 14.88 | 18.08 | 21.22 |
| 15 | 40.9 | 6.94 | 9.14 | 11.70 | 13.83 | 16.80 | 19.73 |
| 16 | 38.0 | 6.44 | 8.49 | 10.87 | 12.85 | 15.61 | 18.33 |
| 17 | 35.4 | 6.00 | 7.91 | 10.13 | 11.97 | 14.55 | 17.07 |
| 18 | 32.8 | 5.56 | 7.33 | 9.38 | 11.09 | 13.48 | 15.82 |
| 19 | 30.4 | 5.16 | 6.79 | 8.70 | 10.28 | 12.49 | 14.66 |
| 20 | 28.1 | 4.77 | 6.28 | 8.04 | 9.50 | 11.55 | 13.55 |
| 21 | 25.8 | 4.38 | 5.77 | 7.38 | 8.72 | 10.60 | 12.44 |
| 22 | 23.9 | 4.05 | 5.34 | 6.84 | 8.08 | 9.82 | 11.53 |
| 23 | 22.0 | 3.73 | 4.92 | 6.29 | 7.44 | 9.04 | 10.61 |
| 24 | 20.3 | 3.44 | 4.54 | 5.81 | 6.86 | 8.34 | 9.79 |
| 25 | 18.6 | 3.15 | 4.16 | 5.32 | 6.29 | 7.64 | 8.97 |
| 26 | 17.2 | 2.92 | 3.84 | 4.92 | 5.82 | 7.07 | 8.30 |
| 27 | 15.6 | 2.65 | 3.49 | 4.46 | 5.27 | 6.41 | 7.52 |
| 28 | 14.4 | 2.44 | 3.22 | 4.12 | 4.87 | 5.92 | 6.95 |
| 29 | 13.2 | 2.24 | 2.95 | 3.78 | 4.46 | 5.42 | 6.37 |
| 30 | 12.0 | 2.04 | 2.68 | 3.43 | 4.06 | 4.93 | 5.79 |
| 31 | 11.2 | 1.90 | 2.50 | 3.20 | 3.79 | 4.60 | 5.40 |
| 32 | 10.1 | 1.71 | 2.26 | 2.89 | 3.41 | 4.15 | 4.87 |
| 33 | 9.3 | 1.58 | 2.08 | 2.66 | 3.14 | 3.82 | 4.49 |
| 34 | 8.4 | 1.42 | 1.88 | 2.40 | 2.84 | 3.45 | 4.05 |
| 35 | 7.7 | 1.31 | 1.72 | 2.20 | 2.60 | 3.16 | 3.71 |

NOTE: *No allowance has been made for the fact that retirements at early ages would show a positive salvage and that retirements at later ages would result in a negative salvage. For the purposes of this study, it has been assumed that the net salvage for retirements at various ages will average zero.

## TABLE 2

### Joint Use on a Space Rental Basis
### Sacrificed Life of Poles Displaced Due to Inadequacy
### Exchange Poles—Based on 21 Year Life Curve

| Year of Age | No. of Poles Remaining in Service | Average Remaining Life Years | Total Average Life Years |
|---|---|---|---|
| 0 | 100,000 | 21.0 | 21.0 |
| 1 | 99,731 | 20.5 | 21.5 |
| 2 | 99,095 | 19.7 | 21.7 |
| 3 | 98,322 | 18.8 | 21.8 |
| 4 | 97,402 | 18.0 | 22.0 |
| 5 | 96,327 | 17.2 | 22.2 |
| 6 | 95,087 | 16.4 | 22.4 |
| 7 | 93,673 | 15.7 | 22.7 |
| 8 | 92,077 | 14.9 | 22.9 |
| 9 | 90,292 | 14.2 | 23.2 |
| 10 | 88,309 | 13.5 | 23.5 |
| 11 | 86,125 | 12.9 | 23.9 |
| 12 | 83,734 | 12.2 | 24.2 |
| 13 | 81,136 | 11.6 | 24.6 |
| 14 | 78,328 | 11.0 | 25.0 |
| 15 | 75,315 | 10.4 | 25.4 |
| 16 | 72,102 | 9.8 | 25.8 |
| 17 | 68,699 | 9.3 | 26.3 |
| 18 | 65,117 | 8.8 | 26.8 |
| 19 | 61,375 | 8.3 | 27.3 |
| 20 | 57,492 | 7.8 | 27.8 |
| 21 | 53,495 | 7.3 | 28.3 |
| 22 | 49,414 | 6.9 | 28.9 |
| 23 | 45,282 | 6.5 | 29.5 |
| 24 | 41,138 | 6.1 | 30.1 |
| 25 | 37,021 | 5.7 | 30.7 |
| 26 | 32,976 | 5.4 | 31.4 |
| 27 | 29,045 | 5.0 | 32.0 |
| 28 | 25,272 | 4.7 | 32.7 |
| 29 | 21,699 | 4.4 | 33.4 |
| 30 | 18,363 | 4.1 | 34.1 |
| 31 | 15,296 | 3.9 | 34.9 |
| 32 | 12,524 | 3.6 | 35.6 |
| 33 | 10,064 | 3.4 | 36.4 |
| 34 | 7,924 | 3.1 | 37.1 |
| 35 | 6,102 | 2.9 | 37.9 |

Two examples are given below to illustrate the use of these tables:

(a) A 35-ft. pole, 12 years old, has, from Table 1, a residual value of $14.42.

(b) A 35 ft. pole upon inspection is agreed upon as having a remaining life of 8 years. From table 2, the age of a pole having an average remaining life of 8 years is 19 years. Then from Table 1, the residual value of a pole 19 years old is $8.70.

The agreement also specifies that when one party does work, the labor cost of which is to be borne by the other party, that to the actual costs of productive labor, trucking, travelling, board and lodging will be added 40 per cent. This 40 per cent is to cover supervision, administration overhead, pension, insurance, lost time due to bad weather, tool depreciation, holidays, sickness, etc. It is understood that each party will absorb its own direct charges for engineering.

There is one point that the agreement does not seem to cover fully. When the owner of the pole makes certain changes which require a re-arrangement of the tenant's attachments or when the owner changes poles for reasons other than deterioration or valid requirements of property owners or governing bodies, which party pays the re-arrangement costs of the tenant?

It is thought that in such cases the tenant should not be called upon to pay this expense as he has been allotted certain space and should be allowed undisturbed possession except for pole replacement on account of deterioration, in which case he would be expected to transfer at his own expense. For rental free attachments, it would appear reasonable that the tenant should bear his own costs.

### TREE TRIMMING

It should be noticed especially that the definition of Transferring and Re-arranging provides that these terms include any tree trimming made necessary by the changed location of circuits due to joint use. The cost of this then is chargeable properly to the applicant in case of re-arrangements for joint use of poles.

The agreement also provides under article XI that the owner of the poles must maintain the circuits of both parties clear of trees at all times. This avoids the necessity of arranging for tree trimming by two parties and having two parties trimming the same trees. The owner of the poles does not necessarily have to do the trimming but may request the other party to do the work at the owner's expense. This provision for tree trimming is only for maintenance. At the time of the original installation each party must pay for its own trimming unless it is chargeable under re-arrangements as noted above.

### MAINTENANCE

The agreement sets out that poles and other equipment must be maintained at all times in accordance with the specifications that form part of the agreement. Provision is made for the enforcement of this in case one party does not, upon request, do the necessary work. It should be noted that failure to live

up to the requirements of the specifications may result in responsibility in case of accidents.

### Term of Agreement

The agreement when signed remains in force for a period of ten years and thereafter for periods of five years but may be terminated by the giving of notice five years prior to the expiration of any of the above periods.

Each permit under the agreement is for a period of ten years and continues until terminated by notice in writing one year in advance of the desired date of termination. If and when an agreement is cancelled, which must be done of course in accordance with the conditions outlined above, each permit remains in force until the expiration of the ten years from the date the space was made available. Therefore, in such case, it will be necessary to give notice of cancellation of each permit under the agreement. (Article XXIV).

On the other hand, so long as the agreement or any permit under same, remains in force, either party may at any time terminate his use of any joint pole. If the owner abandons the use of a joint pole, the tenant has the privilege of purchasing the pole at its value at the date of abandonment; if the tenant abandons the use of a joint pole previous to the expiration of five years from the date space was made available on that pole, he must pay rental for the balance of that five-year period. (Article XIV).

### Specifications

The specifications shown as Exhibit "D" in the agreement provide for certain requirements to be met in the construction and maintenance of jointly used pole lines.

As it is not expected that joint use in excess of 5,000 volts will be encountered often in urban municipalities in Ontario, it is the intention of the writer to select the important points from the specifications in connection with this voltage as a maximum.

### Clearances

A vertical clearance of 4 feet must be maintained between all power and telephone conductors. This may be reduced to 40 inches between the lowest metal parts of brackets, transformer cases, etc., and the uppermost telephone attachment. This applies to all power wires used as current carriers. In the case of guy wires, span wires supporting lamps, etc., a clearance of 2 feet from crossarms carrying telephone conductors or of one foot from telephone cable is required. A clearances of 12 inches is required, where it can be obtained, between the metal bracket of street lamps and the nearest telephone equipment.

Horizontal clearance between line conductors on crossarms shall not be less than 12 inches.

### Vertical Runs

Probably the greatest difficulty in joint construction will be encountered in connection with vertical runs on the pole.

There are three types of vertical runs likely to be met, (a) street

lighting, (b) drops to transformers and (c) connection between underground and overhead circuits. These will be dealt with below in turn.

(a) *Street Lighting*

Vertical runs for street lighting will occur in construction covered by practically every agreement. The runs should be made on the street side of the pole. For either multiple or series street lighting these runs may be made in either of the following ways:—

(1) Multiple conductor cable carried on pins and top tie insulators.

(2) Rubber covered wire enclosed in conduit. The conduit must be permanently and effectively grounded or else covered with a wood or other insulating moulding.

In either of the above the conductors must be insulated for the maximum voltage of the circuit in which they are connected.

A ground will be accepted as permanent and effective if it occurs within a built up area and it is bonded to the neutral wire of a multi-grounded system and the neutral wire is connected to a public water system at every service.

The above two alternatives are all that are provided in the specifications. However, below are suggested, two other methods that may be used upon approval by the Hydro-Electric Power Commission of Ontario.

For multiple lighting a two-conductor concentric cable, having a copper core with a rubber covering and then a copper spiral or braid which in turn is weatherproofed, may be used. The copper spiral or braid is used as a neutral so that the ungrounded conductor is afforded mechanical protection. This concentric cable may be attached to the pole by means of pipe straps so arranged that abrasion of the cable cannot occur—see illustration 1. This makes a very safe and cheap method for making vertical runs.

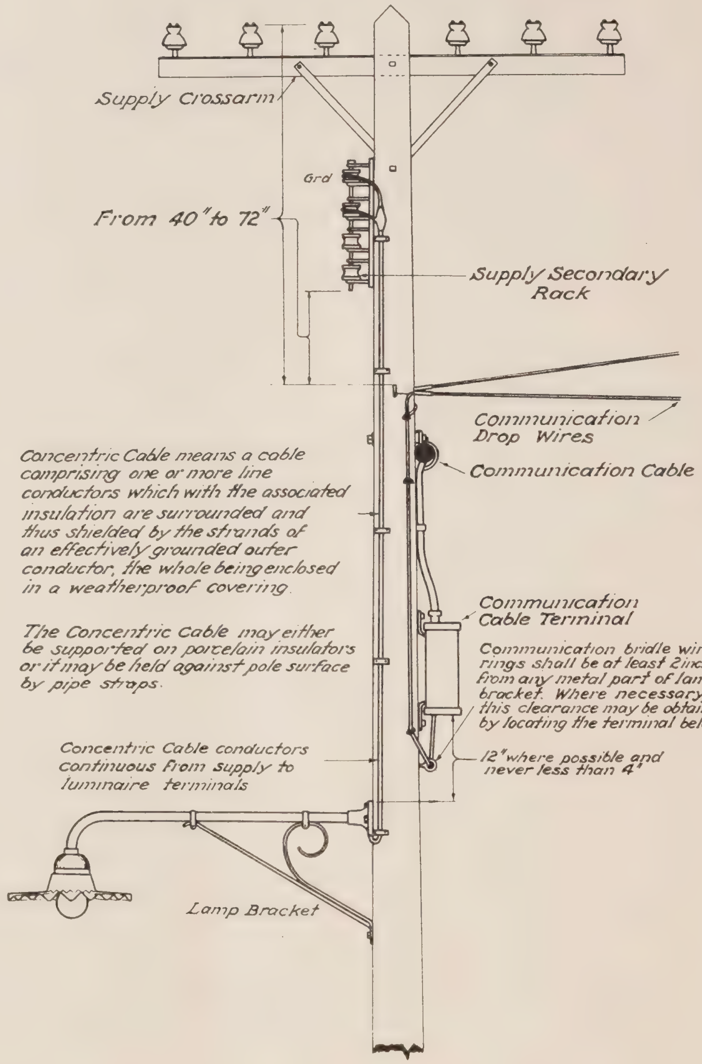
For series lighting a duplex cable may be dropped from the end of the crossarm direct to the lamp bracket provided it is fastened securely to the crossarm and to the bracket and that the cable is maintained at a distance of 40 inches from the pole where below the top of the neutral space and provided there is sufficient insulation between the lamp head and the bracket. If these requirements are met there need be no restrictions as to the insulation of the cable insofar as these joint specifications are concerned. Illustration 2 shows this method of construction.

If either of the above methods are used it will be necessary to have some form of supplement to the agreement signed to allow for the use of same. No doubt the approved agreement will be revised from time to time as changes appear desirable.

(b) *Transformer Drops*

The specifications provide that transformers shall be placed above telephone circuits unless of over 37½ kv-a. total capacity for 25 cycle or 50 kv-a. for 60 cycle. If the transformers are to be mounted below the telephone circuits, the method of construction is not covered by the specifications. There has been some study made as to the best method to do this and at least two cities

ILLUSTRATION 1
MULTIPLE STREET LAMP INSTALLATION
USING CONCENTRIC CABLE for VERTICAL RUN

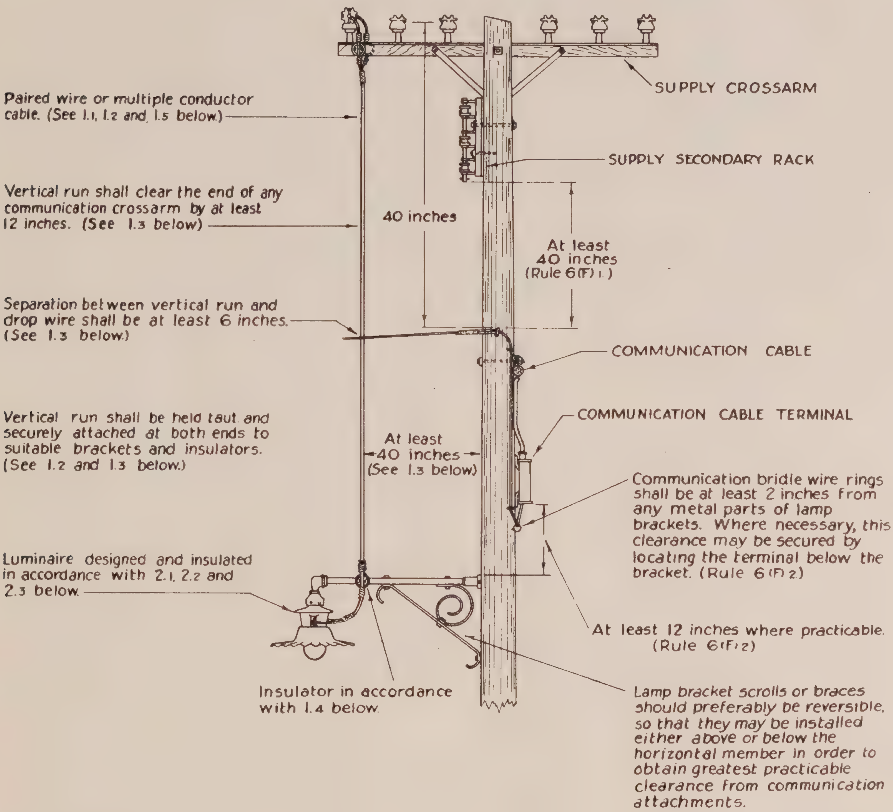



have arranged for such installation in co-operation with the engineers of the Bell Telephone Company.

It should be noted here that the specifications as they appear in the agreement have been approved by the Hydro-Electric Power Commission of Ontario and any deviation from these specifications must receive the approval of the Commission.

# ILLUSTRATION 2

## STREET LAMP INSTALLATION SHOWING VERTICAL RUN MADE DIRECTLY FROM END OF SUPPLY CROSSARM.




1. Vertical Run
   - 1.1 Lamp leads of street lighting circuits may be run from a supply crossarm directly to a street lamp bracket or luminaire as shown above under the following conditions.
   - 1.2 The vertical run shall consist of paired wire or multiple conductor cable, securely attached at both ends to suitable brackets and insulators.
   - 1.3 The vertical run shall be held taut at least 40 inches from the surface of the pole (through the communication space), at least 12 inches beyond the end of any communication crossarm by which it passes, and at least 6 inches from any communication drop wires.
   - 1.4 Insulators attached to lamp brackets for supporting the vertical run shall be capable of meeting, in the positions in which they are installed, the same flashover requirements as specified in 2.1 below for luminaire insulation.
   - 1.5 Each conductor of the vertical run shall be No. 10 A.W.G. or larger.

2. Luminaire
   - 2.1 The current carrying metal parts of a luminaire (except lamp leads) shall be insulated from non-current carrying metal parts by porcelain or its equivalent. Such insulation, except for installations where the voltage of the circuit in which the lamp is connected does not exceed 300 volts between conductors, shall be of wet process porcelain or its equivalent and, when dry, shall withstand the following voltages without flashover between the live parts and the non-current carrying metal parts.

| Full Load Circuit Voltage | Flashover Voltage |
|---|---|
| 300 to 500 | 5 kv |
| 500 to 1,500 | 10 kv |
| Over 1,500 | 25 kv |

   - 2.2 Luminaires shall be so designed that accumulations of dirt or moisture cannot form a conducting path between the live parts and the non current carrying metal parts.
   - 2.3 Luminaires having bare metal terminals located outside the housing shall not be located less than 40 inches in any direction from a communication attachment. Such units shall be so designed as to prevent, as far as practicable, breakdown between the terminals and the non current carrying metal parts.

3. Lamp Leads
   - 3.1 Lamp leads shall be brought into the luminaire in such a way as to prevent as far as practicable breakdown between conductors and metal parts.

There has been objection taken by some municipalities to the mounting of transformers at the height indicated on joint poles. The experience of the telephone companies leads them to the conclusion, that to provide satisfactory working space for telephone employees it is desirable to provide a clearance of 40 inches between the telephone attachments and the bottom of the transformer case.

If the telephone cable is mounted 18 feet above the ground, the bottom of the transformer case will be only 22 feet above the ground which should be satisfactory.

(c) *Connections Between Underground and Overhead Circuits.*

For vertical runs connecting underground and overhead, the cable shall be covered with a wood or other insulating moulding from a point 8 feet above the ground to a point 40 inches above the highest telephone attachment or else the cable may be run in a metal pipe, if the pipe is permanently and effectively grounded.

### Pole Steps

The pole stepping as outlined in the specifications is a compromise between the power and telephone requirements. If there are transformers or switches on a pole, the pole must not be stepped below the 8-foot level with permanent steps.

Only in case there is a cable terminal on the pole and no transformers or switches may the pole be stepped as shown on plate 15. If the pole is stepped as shown on plate 15 care must be taken to see that there are no steps above the telephone cable. It is essential that care be taken to see that the rules in regard to pole stepping be followed.

### Guying

There is a tendency in municipal construction to avoid the use of guys for the lesser unbalanced strains. This is due to the difficulty in obtaining permission to locate anchors in lawns, etc. The absence of guys shows up in slack conductors in a short time. On joint lines it is essential that unbalanced strains be guyed as slackening of conductors means reduced clearances at the centre of spans. The tensions used in messengers carrying cables is so high that the telephone company is forced to install anchors. It may be arranged between the two parties to the agreement to have the party owning the poles install anchors suitable for both parties when there is unbalanced strain in the circuit of both parties.

### Strength Requirements

The requirements of the specifications in regard to clearances, vertical runs, etc., may be checked readily by inspection. The question of strength, however, calls for much more detailed study.

It is the custom in calculations in connection with wood pole lines to assume that the pole is a rigid structure with uniform fibre strength. While we know that these assumptions are not correct, still the results obtained appear to check very well with practical experience.

The specifications call for Grade "C" construction on joint lines where the power line is less than

5,000 volts. The requirements of Grade "C" as set out in the specifications are not very severe except in regard to guying as will be explained later.

*Loading*

For the purposes of loading assumptions, the province is divided into two areas as shown on the map on page 9 of the agreement. Most of the southern part of the province is in the "heavy loading" district which requires the assumption of a maximum loading of one-half inch of radial thickness of ice plus 8 lbs. per square foot of wind pressure.

A report has been prepared by Mr. R. E. Jones of the H.E.P.C. giving the result of observations of the occurrence of ice loading during the past 40 years. This report shows that it is extremely rare to have wind and ice occur coincidently to the extent specified under "heavy loading". A copy of this report is available to any who may be interested in the subject.

*Poles*

A paper was presented by the writer at the summer convention at Windsor in 1933 entitled "Wood Poles—Loading and Strength." This paper set out the method of calculating the loading conditions and also the choice of pole to meet this loading.

The method as outlined in that paper is satisfactory for use to meet the requirements of the specifications. There is some doubt now as to the fibre strength remaining in old wood which appears to be sound. Tests have shown that wood that has been in service for some time but is apparently sound does not always retain its original strength. Sufficient data on this is not available to set up any findings as to the rate of decrease in strength. The above remarks apply to untreated poles. However, it would appear that the reduction in strength of wood is offset to some extent by the infrequent occurrence of the assumed loading.

In Grade "C" poles are allowed a reduction to a factor of safety of 0.66 before replacement.

*Guys*

More difficulty will be encountered in meeting the specifications in regard to guying than to any other part. According to the specifications, a factor of safety of 1.33 must be maintained in guys in Grade "C" construction. This factor of safety is based on the theoretical tension in the guys due to the loading of ½ inch of ice and 8 lbs. of wind simultaneously on all conductors.

To illustrate how strong the guying required is, an example is given below of an average power condition. Suppose it is necessary to design a guy for deadending 3-No. 4 W.P. copper primary, 2-No. 2 W.P., 1-No. 4 W.P. and 1-No. 4 M.H.D. bare copper secondary on 35-ft. pole. That would be quite an average load for a municipality. If the anchor is placed away from the pole a distance of 20 feet, the following guying will be required, assuming the tension in the conductors to be 40 per cent. of the ultimate strength when loaded and the guy at-

tached to the pole at 28 feet above ground:

Total tension in wires.......... 5,100 lbs.
Total tension in guy cable 9,027 lbs.
Allowable tension in 5/16-inch guy cable for f. of s. of 1.33..........=4,500 lbs.
2-5/16-inch guys will be required.

If in the above example, the anchor were placed at 10 feet out from the pole, the following guying would be required:

Total tension in wires.......... 5,100 lbs.
Total tension in guy cable 15,200 lbs.
Allowable tension in 5/16-inch guy cable for f. of s. of 1.33.......... 4,500 lbs.
4-5/16-inch guys will be required.

How many municipalities have guying of that strength for an average condition such as above?

It is evident that the calculated stresses in guys do not check with experience. Tests are being made to determine a more accurate method of calculating guy strains, but no definite conclusions have been reached as yet.

We are, therefore, faced with this condition on joint lines. Either we install guying that we feel is excessive merely to meet the specifications or else we install guys below the specifications and take the chance of liability due to failure in these guys.

Discussion is under way at present with a view to reducing the factor of safety below 1.33, but the trouble is that nobody knows to what extent it may safely be lowered.

The above is based on hard-drawn guy cable with a strength of some 6,000 lbs. If soft-drawn guy cable is used with a strength of only 3,300 lbs., the pole would be cluttered with guys.

*Crossarms*

The specifications allow the use of single crossarms under all conditions below 5,000 volts. It is not recommended, however, that conductors be deadened on single pins.

*Pins and Ties*

Pins and ties shall have sufficient strength to meet an unbalanced pull of 700 pounds. It may be difficult to meet this in single ties, but it is not so important, because if there is an unbalanced pull of 700 pounds on a conductor, a small slippage at the tie will reduce the unbalance. At deadends, however, this condition should be met either by the use of double arms and pins or else by means of a deadend clevis.

*Conductors*

The requirements for conductors for Grade "C" are not severe, as No. 8 copper is satisfactory up to 150-foot span.

## Plates

The plates at the back of the agreement illustrate the clearances, etc., pointed out in the specifications and may be used as a guide in joint use construction.

## Conclusion

The above covers the important points in the operation of the agreement and specifications. Satisfactory joint tenancy is dependent on co-operation. If both parties live up to the terms and specifications as outlined above, they should be able to maintain amicable relations in the joint use of poles.

*Vessel stranded on beach at low tide.*

# Tides and Tidal Rivers

THE tides of the oceans are movements of the waters, rising and falling with horizontal motion also as they rush into bays and rivers to which they have access. These movements are periodic, high and low tides occurring in regular succession slightly more than six hours apart.

Tides are caused by the mutual gravitational attraction between the waters of the earth, on the one hand, and the moon and sun on the other. These forces, coupled with the rotation of the earth on its axis, cause the waters to be drawn westward at first, but as the rotation continues the forces are reduced and the waters are released to fall to lower levels following which the attraction is to the east drawing them back in the opposite direction.

The tide-generating force of the moon is more than twice that of the sun so the former produces the more noticeable tidal effect. This has led to the popular but erroneous thought that the moon alone controls the tides. The effect of the sun, however, is quite evident in modifying the moon's control.

There are three types of tides,—synodic, anomalistic and declinational. These all occur together over the surface of the oceans but usually one or other of these components predominates.

### SYNODIC TIDES

This type of tide depends upon the position of the moon in relation to the direction of the sun,—i.e., the phases of the moon. When the moon and sun are together,—"new moon,"—their forces combine and are greater than when these bodies are ninety degrees apart,—"first quarter," or "last quarter" moon. When these bodies are on opposite sides of the earth,—"full

moon,"—the tide producing forces are again great, practically equal to those at new moon.

The highest synodic tides, known as "spring" tides, therefore occur when the moon is new or full. With the moon in one of its quarters, the tides are much reduced and these are called "neap" tides.

### ANOMALISTIC TIDES

These tides depend entirely upon the moon's distance from the earth. This distance varies,—about seven per cent. on each side of the average.

When the moon is in "perigee,"—nearest to the earth,—the anomalistic tides are greatest; when in "apogee," —farthest from the earth,—the tides are much smaller. The positions of perigee and apogee occur in regular sequence, nearly fourteen days apart.

### DECLINATIONAL TIDES

The moon varies its declination,—its elevation in the sky,—the *range* in altitude being about fifty-seven degrees as it crosses the meridian. With the moon passing directly overhead, or nearly so, the declinational tides are highest and, alternately, they are least when the moon is at low altitude.

These variations are not associated with the phases of the moon. It may be at any declination within its range while at any phase. In other words the "first quarter" moon recurs at gradually higher positions in the sky until it reaches its maximum; it then appears at gradually lowering positions.

### OCCURRENCE OF TIDES

A westward movement of water commences in the southern Indian Ocean, west of Australia. This continues, increasing, until it passes to the south of Africa after which it turns northward and proceeds up the Atlantic Ocean. Owing to this long path of travel, tides do not reach their high levels on Nova Scotia and New Brunswick shores until about twelve hours after the moon has crossed the local meridians. There the three types of tide may be found in close proximity as to location, Fig. 1.

The Bay of Fundy presents a wide opening to ocean waters at the south and tapers to narrow dimensions, width and depth, at the north-east end, the Minas Basin. This bay is unique in having the highest tides in the world,—a range of 56 ft. from high water to low water, at Burntcoat Head. The tides here are of the anomalistic type.

At Hopewell, New Brunswick, another point at the north-east end of the Bay of Fundy, the maximum range of the tides is 46 ft. Here are found some very interesting "flowerpot" rocks, Fig. 2, which show a definite high-water mark, the upper limit of the erosion caused by the waves beating against them through the centuries.

Wherever tidal waters run into bays, the range of tide at the end of the bay always far exceeds the range at the mouth. This is due to the fact that the waters are crowded against the shores, the energy in the horizontally moving waters appearing as potential energy to raise the levels at high tides, and also to lower them by withdrawing energy at low tides.

### TIDAL RIVERS

Where a river, or smaller stream, empties into an ocean, or into a bay which is subject to tides, the flow of

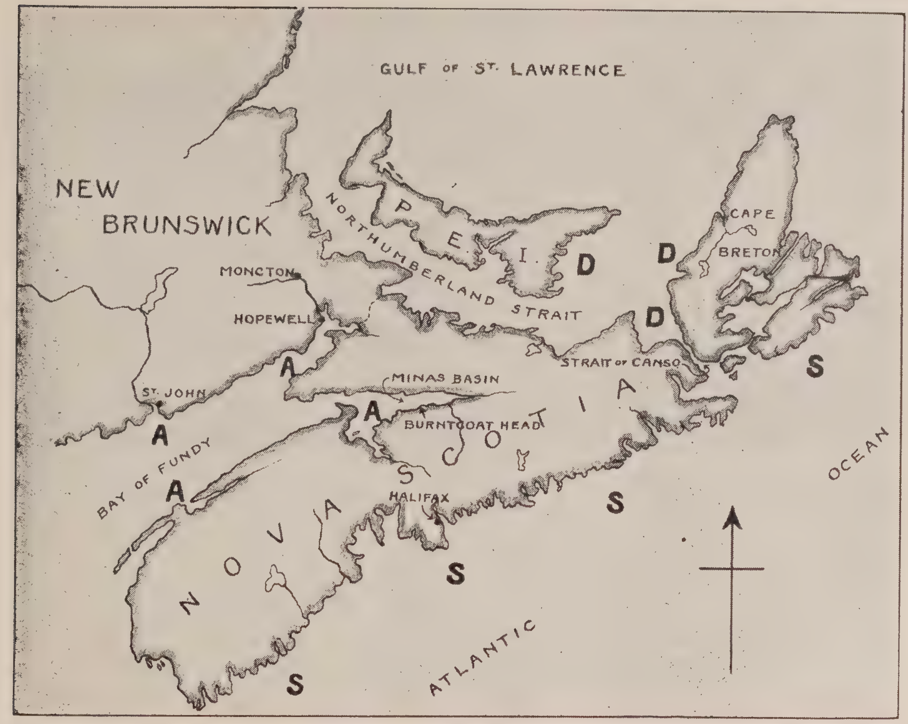



*Fig. 1—The three types of tide in close proximity as to location. S—Synodic tides on the Atlantic Coast. A—Anomalistic tides in the Bay of Fundy. D—Declinational tides at the north end of the Gut of Canso.*

*Fig. 2—Flower-pot rocks at Hopewell, New Brunswick, showing the high water mark produced by erosion. This level line has been the upper limit of spring tides through the centuries.*

*Fig. 3—A tidal river, near Moncton, N.B., at low tide, showing the wet clay banks and the small natural flow. At high spring tides, the water rises almost to the top of these banks.*

the river waters is reversed in direction when the tide is rising, and, conversely, the natural flow is greatly augmented when the tide is ebbing and the tidal waters withdrawing from the river, Fig. 3. This effect may occur for several miles upstream from the mouth of these "tidal rivers."

In the St. Lawrence River, the incoming tidal waters from the ocean push back the river waters in a body so that salt water is found as far up as Riviere du Loup. Above this point there are fresh water tides even up to Lake St. Peter, above the city of Three Rivers.

The Reversing Falls at St. John, N.B., are due to the tides. This is not a waterfall, however, but rather rapids, over a rough river bed, which flow alternately upstream and down. At times of "slack water," at high tide,—a short period when the water levels stop rising and before they commence to fall,—navigation is possible over the "Falls" to points farther up the St. John River.

In all of the large tidal rivers, the tides are of considerable advantage to commerce in allowing access to ports which could not be reached with normal or average water levels. In many of these streams, vessels sail up with the tides and, as the waters recede, are gradually lowered to rest on mattresses. The water may drop to levels many feet lower than the bottom of the vessel's hull but while it is on the mattress, its cargo is unloaded and a new cargo placed on board. The vessel then sails out, downstream, with the next ebbing tide and natural river flow.

The tides are of some disadvantage, however, as it becomes necessary to provide the wharves and docks with means of unloading vessels, both for passengers and cargo, at all various water levels which may obtain at the particular port. This provision may take the form of a ramp, a sloping

passageway, permanently installed, where the vessel may dock at a point where deck and ramp are at the same level, or it may be a sort of bridge span, hinged at the land end and arranged to have the outer end raised or lowered by chains to suit the level of the vessel's deck when it arrives in port.

### Tidal Bores

As the tidal waters proceed up some rivers, they form what is known as a "tidal bore," a wave front of water advancing against the opposing current of the river and immediately followed by the rising tide. The arrival of the bore, with its steady onward motion, is a most impressive sight, even awe-inspiring when one realizes that this is caused by those far-distant celestial bodies, the sun and the moon.

Certain conditions are necessary for the formation of a bore. There must be a considerable and rapid rise of tide, and also a converging channel with a rising bed such that the depth of water is decreasing as the channel is approached, its progress being impeded by sand banks, or shoals, through which there are channels kept open by the ebb tide and the river flow.

The largest bores take place at spring tides and the effect is much increased if an on-shore gale is driving the water up the river. At neap tides, the bore may be hardly noticeable,—only a mere ripple.

A few notable examples of bores in well-known rivers are as follows:—

The Severn and Trent Rivers in England.

The Seine in France.

The Tsien-Tang-Kiang in China.

The Amazon River in South America.

The Petitcodiac River in Canada.

These rivers discharge into estuaries with large areas of sand, the channels converge and the range of the tide is high.

The Petitcodiac River in New Brunswick is of special interest, being an outstanding example and comparatively near at hand. This river is connected with the Bay of Fundy by an estuary about 32 miles long. At Moncton, 20 miles from its mouth, it is about one-half mile wide, the normal river channel being 500 ft. in width running through mud flats that dry at low water. The rise of tide at the river's mouth, a Fundy tide, is very high, having a maximum range of 46 feet.

The tide first shows the character of a bore about 8 miles below Moncton. As the bore comes around the bend of the river, near the city, the wave front loses its smooth appearance becoming broken and bubbling, as shown in Fig. 4. This front advances steadily, passing the observer at a rate of about 8½ miles per hour. The greatest height that has been observed in this bore is 4 feet, the average being 3¼ feet.

The bore here is caused by anomalistic tides and therefore is maximum when the moon is in perigee, i.e., nearest to the earth. With the moon in apogee, its farthest distance, the bore may be just a small ripple, Fig. 5, and its arrival may hardly be noticeable. In any case, however, a bore is of considerable astronomical interest.

*Fig. 4—The tidal bore on the Petitcodiac River, arriving at Moncton, N.B. This was the highest bore in the year 1934—a most impressive sight.*

### TWO HIGH TIDES PER DAY

There sometimes is difficulty in understanding how there can be two high tides in a day when the moon cannot cross the meridan more than once during that time. This phenomenon may be explained, with reference to Fig. 6, as follows:—

The moon attracts both the water and land of our planet. The water can move, consequently it is drawn up "into an heap" under the moon. On

*Fig. 5—The tidal bore at neap tide, as it arrives at Moncton, N.B.*

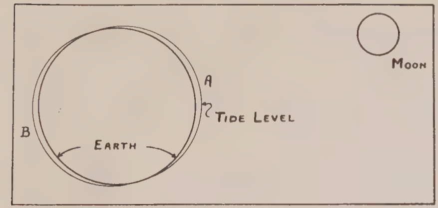



*Fig. 6—High tides occur almost simultaneously on opposite sides of the earth. At A, the moon draws the water into a heap. At B, the moon draws the solid earth away from the water, which forms into a heap before following it.*

the other side of the earth, however, the land, the solid part, is attracted more forcefully toward the moon than the water which is "above" it and therefore actually farther from the moon. Thus the land is drawn away from the water, which again forms into a heap before following the solid matter. This is the equivalent of having another moon, on the other side of the earth, to draw the water with equal force but in the direction away from the actual moon. For this reason, high tides occur nearly simultaneously on opposite sides of the earth.

### Analysis of Tides

The variations in tide levels may be analyzed into combinations of simple harmonic waves, and these components may be determined for different ports throughout the world. The height of the tide at any future date may then be computed. Lord Kelvin in 1872, devised an instrument which would both analyze recorded tides and also compute the future levels. Two such instruments are now at the University of Liverpool Tidal Institute and there is one in Chicago,—ingenious and weird mechanical devices which take into account thirty-five different factors to predict the level of the tide at any port in the world for any date in the future, thus giving information which will be required when ships which are yet unbuilt set sail on voyages which are yet undreamed.

### Other Tides

While the tides are usually considered as being movements of ocean waters only, there are other tides known. In seas, lakes or, in fact, any body of water no matter how small, there must be tidal effects but these rarely are large enough to measure. Tides exist also in the atmosphere but these too are small and cannot be measured easily as their effects are practically insignificant in comparison with winds and ordinary variations in barometric pressure.—*F. K. D.*

## Getten' 'Em Goin' and Comin'

A public utility extended its electric service to a small rural community. One householder quietly watched a lineman erect the service lines to his house. Finally he asked:

"Why is it necessary to fix two wires to every house?"

The lineman proceeded to explain.

"Well, it's like this," he said, "the current comes down one wire and returns on the other."

The man nodded his head gravely.

"Ay," he murmured, "I see where the catch is now. We pay for it, and the company takes it back again!"

—*The Electric Journal.*

# Municipal Hydro-Electric Pension and Insurance Plan

By Fred. A. Robertson, Acting Secretary and Treasurer, Municipal Pension and Insurance Committee, and A. S. Robertson, Director of Associated Services, The Confederation Life Association, London Life Insurance Company and Mutual Life Assurance Company of Canada

*(Presented to the Association of Municipal Electrical Utilities at Toronto, February 8th, 1938)*

INTEREST in the Municipal Hydro Electric Pension and Insurance Plan is increasing from year to year, to such an extent that it was felt there might be a place for a report detailing the provisions of the plan and its growth to supplement the report of last year, which dealt with the plan largely from a historical point of view.

The general structure of the plan is probably well enough known, but it will no doubt be of very much interest to have the individual provisions set out and an example given of what the result is in the case of a typical employee.

The benefits of the plan fall naturally into two divisions—

### Life Insurance Section

Under the Life Insurance section, protection in amount equal to one year's salary, increasing by 2½ per cent. annually up to a maximum of 1½ years' salary is provided for each permanent employee. In the event of death from any cause whatsoever, the life insurance will be paid to the beneficiary named by the deceased employee. Within the provisions of the Law, beneficiaries may be changed at any time upon written request. When, however, an employee actually reaches the normal retirement age of 65 years, the amount of such employee's insurance abates to 70 per cent. of the amount in force in the year immediately preceding attainment of age 65.

A Conversion Option in connection with the Life Insurance benefit is also available to any employee who withdraws from the service of his Commission prior to retirement. Under this option a withdrawing employee shall have the right, upon written application and with the payment of the required premium within thirty-one days of withdrawal, to obtain without any evidence of insurability a policy of life insurance on any one of the regular Life or Endowment plans then issued by the Companies, for an amount equal to that for which he was insured under the plan at the time of his leaving the service of his Commission.

### Pension Section

The Pension section of the plan, again, shows three distinct divisions:

Service "A" pension, purchased by the employer, which is granted in recognition of the past service of employees and is equal in amount to 1

per cent. of the present salary of the individual employee multiplied by the number of years of service for which credit is allowed.

Service "B" pension, purchased by the employer, which is the pension earned during the current service year and is in amount equal to 1 per cent. of the annual salary of the employee for the then current year.

Income Annuity pension—the third phase of the pension benefit—is that amount of annuity purchased by the employee according to the amount of contribution made by him at his age at entry.

The sum of the Service "A" pension, the Service "B" pension purchased from year to year, and the income annuity pension purchased from year to year constitutes the employee's final pension, which is payable when the employee reaches the normal retirement age of 65 years.

Provision is made in the plan for retirement at earlier or later ages than the normal retirement date at the option of the employer and employee. These optional retirements are permitted between the ages of 55 and 70.

Further provisions are made in the event of the death of an employee either prior or subsequent to retirement, or in the event of an employee leaving the service prior to retirement age.

In the event of the death of an employee prior to retirement, in addition to the amount of life insurance then payable to his beneficiary under the life insurance section, there will also be returned to the employee's beneficiary an amount equal to the employee's contributions toward the purchase of his income annuity pension benefit.

Again, in the case of the death of an employee subsequent to retirement, in addition to the amount of life insurance payable, there will be returned to his beneficiary an amount equal to the difference, if any, between the employee's total contributions toward the purchase of his income annuity pension benefits and the total amount of income annuity benefits paid to him.

In the event of an employee leaving the service of his Commission prior to reaching his retirement age, there will be returned to him in full his contributions toward the purchase of his income annuity pension benefits; if such employee should have completed 20 years of service there will also be a further benefit in the form of a paid-up deferred annuity, which becomes payable at the employee's normal retirement age. This paid-up deferred annuity represents the amount of the Service "A" and Service "B" pension benefits which have been purchased for him up to the time of his leaving the service and which vest in such employee on account of his length of service under the terms of the plan.

The above sets out in brief form the benefits to the employees under the plan and the following is an illustration of such benefits in a typical employee case—

Example—Consider an employee aged 30 at the entry of a Municipality into the plan. It is assumed that this employee is credited with five years' of past service, and that his

salary is $100.00 per month. It is also assumed that his salary remains at this amount. A subsequent increase in salary would result in increased benefits.

A. *Monthly Pension Benefit at age 65.*

(a) For service prior to the entry date 1% of monthly salary for each year of past service ............ $ 5.00

(b) For service subsequent to entry date, i.e. for 35 years' of future service. Amount of pension purchased each year is 1% of monthly salary, and in 35 years the total purchased would be ............ 35.00

(c) Each month the employee would contribute $3.00 of his salary to the plan, and this contribution would purchase a further monthly pension of ............ 30.75

Total Monthly Pension at age 65 ............ $70.75

B. *Life Insurance Benefit.*

Initial amount of Life Insurance ............ $1,400.00

The Life Insurance Benefit would be increased by $30.00 each year (taken to the nearest $100) up to a maximum benefit of 1,800.00

After retirement the Life Insurance Benefit would be ............ 1,260.00

Adequate insurance protection is a vital present-day need and the growth of the Municipal Hydro-Electric Pension and Insurance Plan is just one more indication of how general is the recognition of this need and to what an extent co-operative employer-employee welfare plans are being developed to meet a situation of such vital importance, not only to the employee himself but also to the employer. The growth and development of the plan is shown very graphically by the comparative tables below—

| | At end of 1929 | At end of 1933 | At end of 1937 |
|---|---|---|---|
| 1. Number of Municipalities included | 18 | 46 | 51 |
| 2. Number of employees included | 964 | 2,072 | 2,202 |
| 3. Amount of Life Insurance Benefit in force | $1,836,570 | $4,319,900 | $4,689,865 |
| 4. Amount of Monthly Retirement Income being purchased | 61,558 | 145,887 | 155,149 |
| 5. Number of employees at present drawing pension | ............ | 21 | 81 |
| 6. Amount of Monthly Pension being paid | ............ | $337 | $1,740 |
| 7. Number of Death Claims | 2 | 51 | 111 |
| 8. Amount paid out in Death Claims | $3,400 | $98,010 | $227,830 |

THE
# BULLETIN

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# Freighting in Northern Ontario

IN the Districts of Kenora and Patricia, north of the line of the C.N.R., lies a trackless country of lake, swamp and rolling hill, rocky and covered with forest. From the air there appears to be nearly as much water as land, most of it in the form of lakes ranging in size from the small isolated spring pond of an acre or so to large and much indented bodies like Lac Seul and lake St. Joseph, each more than fifty miles long. Nearly all the larger water courses, both rivers and lakes, run more or less in an easterly-and-westerly direction. Between them the divides rise to no great height, for the country is of great geological age, and is generally flat or rolling though at the same time much broken up, and rocky and rough in surface. Beyond the height of land which throws the waters of Lac Seul to the south and west, the rivers drop down a gradual rocky slope into James bay, the brown waters of the Albany, the longest and greatest of entirely Ontario rivers, forming the dominant channel of the district. Because of their comparatively rapid descent to the sea, the river courses are much broken up by rapids and falls, though few of the latter are over thirty-five feet in height. Consequently, navigation on all the streams, in their natural state, is a difficult and arduous undertaking, and only practical in small craft.

Untraversed as it is by road or railway yet, this area is the field of many active commercial undertakings, most of which are mining ventures located between one and two hundred miles from railhead. Settlements are naturally far apart. The main activity is centered in three principal mining areas; the Red Lake area to the west, the Woman Lake area in the middle, and the Patricia group in the Albany river basin to the east. The first group is served by Ear Falls power development, and the last by Rat Rapids development. To support the

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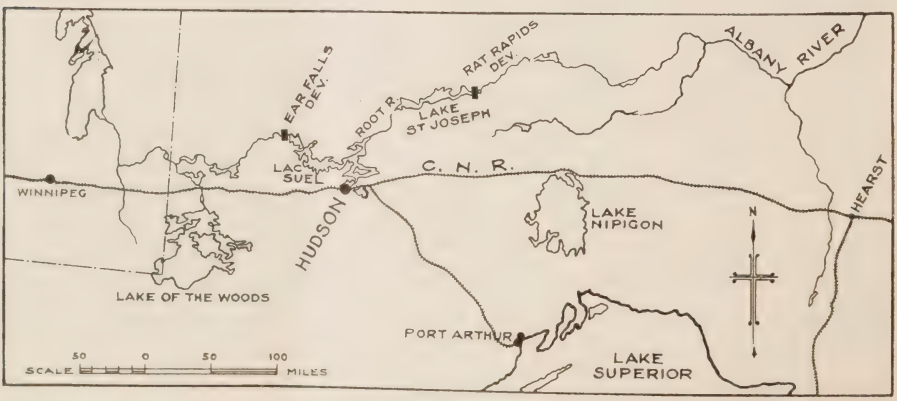
**Vol. XXV** **No. 5**
**May, 1938**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

needs of the mines and their dependent communities, many thousands of tons of materials and supplies must be moved over this pathless country, and the ceaseless ebb and flow of travellers transported quickly, safely and comfortably. Summer or winter, this flow must be kept up. It is no longer considered sufficient, or indeed practical, to provide a years' stock of supplies by winter transport, and leave a community isolated from the time of the spring break-up until the ice again permits communication with the outside. Constant and dependable transportation systems are a necessity, and in the past few years these have been evolved and developed through the ingenuity of the engineer and the determination and energy of the men who make their livelihood in this service to their fellows on the frontiers.

The Commission's interest in the problems of transportation became acute when it undertook the construction of power developments at Rat Rapids on lake St. Joseph and Ear Falls on Lac Seul, and designed and built the marine railway systems on the Chukuni and Root rivers. Industry is made economically practical and living reasonably comfortable in these remote places by use of the airplane, by tractor trains over winter roads,




*Patricia District water routes to Red Lake and Pickle Crow mining areas.*

and by boat and scow over lake and river routes in the open water season. A most important adjunct to the latter means of transportation are the marine railway systems which span the divides and the broken waters of the rivers and so permit the continuous transit of large vessels and their loads from one water-shed to the other. Without these systems, the ease and cheapness of water transport would be limited to the navigable lakes or rivers adjacent to the railway.

The part played by the airplane in opening up our back country is now fairly well known and will not be described here. It is of interest to note, however, that it was probably in this area we speak of that a plane was first used for the transport of mining equipment, and here also much practical experience has been gathered for the development and successful operation of the freight plane and of other modern means of transport. The planes generally in use have a capacity of about one ton, though some carry twice that pay load. They are on the job winter and summer alike, save for brief periods at break-up and freeze-up, when skis are changed for pontoons or vice versa. No man-made aerodromes are available with their lights and other aids to pilots, the water of the lakes in the summer and their snow-clad surfaces in the winter form the landing fields, and neither is at all times in ideal condition. Only total lack of visibility halts the ceaseless air traffic, and those who make use of these routes will bear witness to the fact that no more resourceful or more skilful pilots may be found anywhere in Canada. They may not wear any recognizable uniform or bear even a remote likeness to the typical pilot of the movies, but their long record of flying without serious accident, and the mountains of freight they move, speak for their capabilities.

Much less is known of the two other forms of transportation, so a brief description of what they involve may be of interest. As a typical example, let us take the journey from railhead to the Rat Rapids generating station at the eastern outlet of lake St. Joseph.

In summer, Hudson is the starting point. Here the freight is transferred from the railway cars to scows and when the flotilla is loaded, it sets off. Three scows form the usual string. They are towed by a diesel-engined tug—this type of internal combustion engine having recently displaced gasoline-powered ones, which, in their turn, had displaced steam—each scow being about fifty feet long and nine feet wide and having a capacity of 15 tons. Their size and weight is limited by the design of the marine railway system they will traverse: much larger scows are in use on routes which do not involve movement out of water. For 80 miles the tug and its tow thread the channels of Lac Seul north-eastwards to the Root river where, 12 miles up from the lake, the first of the marine railways is reached at the old Nattaway portage. Essentially these marine railways consist of a broad gauge railway track connecting the upper and the lower reaches of the river at the portage, and extending into the water at each

*Scow being taken over Root river railway to lake St. Joseph. Note 13 ton gasolene locomotive.*

end far enough to allow a scow to be floated on to a low car running on the track. A hoisting engine at the high point of the portage pulls the car up one incline and lets it down the other. Each scow, load and all, is carried over in succession, and the string then taken in charge by a smaller river tug and towed to the next portage. This manoeuvre is carried out three times in all on the Root river system; the lift varies between nine and eighteen feet and the length of the marine railways between 300 and 800 feet. After leaving the last portage at Flower falls, four miles of gradually narrowing and continually more crooked stream has to be navigated until a point is reached beyond which progress is impossible. Here is one terminus of a 3½-mile stretch of standard gauge railway: the most northerly individual system of this gauge in Ontario, its northern end being only about 15 miles south of the latitude of Moosonee on James bay. At this point the scows have to be unloaded, as no facilities exist for portaging them with their contents. The loads are broken out and are carried over the divide to the terminus on lake St. Joseph by freight car. The rolling stock of this railway system consists of a 13-ton gasoline-engined locomotive and two standard flat cars: the section of steel varies from 56 lb. to 70 lb. per yard, and altogether there are some 450 tons of it. Some faint conception of the magnitude of the task involved in the building of the line may be obtained from this fact alone, particularly as it must be remembered that the line had to be constructed simultaneously with the marine railways between it and railhead at Hudson. These were, therefore, not available for the handling of this tonnage of steel by scow and hoist. By the expenditure of much labour and sweat, and helped out by considerable objurgation, up the streams and over three portages it all went, sometimes only one or two rails at a time, ultimately to connect the waters of Lac Seul with the more elevated levels of lake St. Joe. At the

*Chukuni river water route just before freeze-up.*

northern terminus the freight is trans-shipped again from car to scow and after a seventy-mile voyage across lake St. Joseph, arrives at the end of navigation. Here, in Doghole bay at the eastern end of the lake, are wharves and warehouses to hold the goods until they proceed further north to the mines by whatever means of transport are available. Sometimes the rest of the trip is made by air, or the freight may be held for winter road haul, but there has just been completed a 26-mile truck road between Doghole bay and the Pickle Crow Mine, over which most of the freight now reaches its destination. The Rat Rapids plant lies just off the main route two miles south of Doghole bay.

The total length of the water route from Hudson is about 172 miles; the air line distance is about 116 miles. It has been done in forty-eight hours, but the usual time needed for the journey is four full days, and at the best it is no easy journey. The larger lakes are shallow in many places, the channel is twisted and dangerous, and strong winds often whip up sudden seas rough enough to drive the small craft to the nearest shelter, where, wet and cold, the crews may have to remain for hours or even days. In the late fall, while trying to utilize every last day before the inevitable freeze-up—sometimes as early as October 15th—snow and bitter cold have to be fought, and often a channel must be broken laboriously through ice several inches thick in the sheltered rivers channels and the bays which freeze before the big lakes do. Cold, wet, and tired, the crews keep at it until the last ton that can be carried on open water is delivered, for that can be done at a quarter the cost of winter haulage, and besides, the boats must get back to shelter ere navigation closes. They are likely to be a total loss if caught in the freeze-up and held in the heavy ice till spring.

The cost of transportation by water over routes of the type and distance described is only between one-quarter and one-third of that by tractor train, the next cheapest means available. In the open season of 1936, 4,250 tons of freight were taken over the Root river system and on to the end of lake St. Joseph. The differential between the cost per ton by the water route and

the cost of winter haul by tractor is about $35.00, indicating decreased expenditure for transportation of nearly $150,000 in this one season. As the cost of building and equipping this marine railway system was only about $115,000, some idea of the great value of such facilities in opening up remote areas may be gained, although the monetary saving indicates the smaller part of the benefits provided.

As soon as the freeze-up is an accomplished fact, usually about October 25th, transportation activities temporarily cease. After a few days, the lightest of the planes may resume operations, those carrying mail and serving some particularly urgent need, but there is an interval of at least three weeks before it is generally safe to land freight planes. But while nothing has been moving on the lakes, the mechanics on shore have been busy getting their land machines ready for the work awaiting them. Tractors, ploughs and sleighs are gone over carefully, for only the best of materials and workmanship will stand the shocks and hard grind of the winter road, and break-downs are not wanted a hundred miles out from the home base.

Three methods of hauling freight on sleighs in the winter may be met with in the North Country; by dog team, by horse, and by tractor. Dog teams are used for light loads and for fast travel in emergencies. They can get through where nothing else can and almost every mine in an isolated location has a dog team available for such purposes. A good day's travel is 25 miles, with 100 lb. per dog, the "team" being five or six dogs. Toting by horse and sleigh is now out of date, and on long hauls out of the question on an economic basis. A team requires stopping places about every 20 miles—a good day's travel—shelter, and much care. Its load on this kind of work is limited to two tons or so, and the amount of non-paying load which has to be taken along in the form of horse feed is comparatively large, and so of serious import. For local haulage around settlements and for work in the bush, however, the horse is still indispensable.

In the territories we are dealing with, where permanent roads do not exist, the use of trucks is not practical. Several varieties and adaptations of these have been tried, but so far nothing appears to have been evolved which will overcome deep snow or slush. The best answer to the problem of hauling heavy loads under such adverse conditions over difficult country is provided by the tractor. This is now the established method of freighting, and in the areas we are considering winter road hauls of 125 miles are common. The routes between Hudson and Red Lake, Hudson and Woman Lake, Savant and Pickle Lake, (the latter passing Rat Rapids) are about this length. These routes pass over lakes, swamps, and high land. As much lake surface as practical is selected in choosing the route, for reasons that are obvious, but all lakes do not provide safe roads, and slush conditions on many of them are often particularly bad.

Although the lakes may be frozen over by the beginning of November,

*Tractor train leaving Hudson.*

freighting is seldom possible before the middle of December, and on the Savant—Pickle Crow route—it has been as late as February before the road was safe for freighting despite the fact that the winter had been an unusually severe one. It is hard to believe that this condition can exist, despite the early and often extreme cold of our northern winters, but such is often the case, though an explanation for it is not always easy to find. It may be caused by conditions such as are indicated below. About 9 inches of clear blue ice is the least amount which will safely carry a tractor and medium weight load, but early in the winter possibly only three or four inches of ice may form before a heavy snowfall comes. This blanket prevents further rapid freezing and may sink or crack the ice sufficiently to allow water to well up and turn the snow into slush. This will in turn freeze but will not provide hard ice and before long another snowfall begins the same cycle. While this process of nature may by the end of winter have built up an ice covering two or three feet thick, sufficient strength and thickness is not always available when wanted for tractors. The roadmakers have then to help nature provide this, which they accomplish by breaking up the snow covering on top of the slush and so allowing the cold to penetrate and form ice, but surface watering, ploughing and rolling may all be needed before a safe road is provided.

Both the selection of a route and the making and maintenance of a good and safe road on it are jobs calling for much experience; particularly in the choice of the route, is there needed a kind of instinct possessed by few. Channels in the lakes where no more than the slightest current may exist are dangerous; one day there may be 12 inches of good ice under the road and two days later only four. A similar condition is found in many of the smaller land-locked lakes where decaying vegetable matter is present in large quantities. This matter appears to discharge warmth or gas, which cuts down the thickness of the ice. In those locations, the road must be tested frequently and moved if necessary. This latter type of lake is really only safe to travel on in extremely cold weather. As soon as

*Slush on winter road on Lac Seul.*

*More slush on winter road, probably 24 in. to solid ice.*

the days begin to warm up in the latter part of March, just when conditions are often at their best for freighting, they are very treacherous and need the closest of supervision. Ice cracks form another and fruitful source of trouble, but may often be detected by the surface of the snow cracking also. They are most dangerous when two cracks run together to form a narrow unsupported tongue of ice below the road; the first tractor which comes along may break this off and drop through.

Ultimately the road is made and considered safe to travel. Then freighting begins and the tractor trains set off. Over rugged country where the going is only partly on ice, the usual train consists of a tractor hauling three or four sleighs, each of which carries between five and ten tons. The weight allotted to the sleighs depends on the country to be traversed. Three trains of this size usually form one convoy, a caboose for the shelter of the relief crews of each train being attached to one of the trains. Two drivers are allotted to each tractor, and in addition there go along a brakeman and the captain in charge of the convoy. The drivers usually work in eight-hour shifts, but in bad or really cold weather, 30° to 40° below zero, they will change to four hours on and four hours off or less. The men off duty sleep or shelter in the caboose.

The tractors are not provided with cabs for protection against the weather. The good and sufficient reason for this lack is that should a tractor break through the ice, the driver, muffled up in heavy clothes as he is and more than half frozen would have no chance to get out of the cab, but if free of obstacles, he can get clear of his sinking ship or at least come to the surface if he does go under. Few ever drown, but of all jobs tractor driving in extreme temperatures may easily be considered the worst.

Apart from breakdowns or other unavoidable causes, the trains do not

*Tractor and train crawling through deep slush on Lac Seul—everything O.K.*

stop till their destination is reached. They crawl along at two miles an hour or so when loaded, though they may hit nearly four miles an hour when light. The gasoline-engined tractors average about one mile per gallon for the round trip, a little worse than even our oldest car. An appreciable percentage of the loads hauled is, therefore, taken up by fuel for the engines—though this is very materially reduced in the case of diesel-engined tractors—and expensive though each gallon is when hauled a hundred miles or more from the base, the carelessness and waste attendant on its use is surprising, until one reflects on the nature of the men who drive these trains. Unconcern for such trifles appears to be necessary to the make-up of a man who will disregard much in the way of natural obstacles and get his loads through, "come hell or high water".

Just as gasoline and oil have replaced coal and steam on the boats, so is the diesel-engined tractor ousting the gas-engined type. The advantages in favour of the diesel are many: greater power and traction for the same weight and fewer engine parts are some, but the greatest of all lies in its low cost of operation. Using half the amount of a much cheaper fuel as it does, the gain in pay load alone over a long haul is great and soon wipes out the slightly higher initial cost of the machine.

Sleighing continues till some time in April; up to the last minute it is possible to get a sleigh over poor and rapidly rotting ice. There is always one more load which has to be handled and somehow or other it always—or nearly always—gets in, though conditions may be so bad that the train can only travel after sundown, when the few more degrees of cold afford a little greater margin of safety than during the day. Little has been said about the slush, often encountered 12 and 18 inches deep on the ice, and much the worst of the many obstacles to be overcome. There may even be two layers of ice on a lake, separated by a layer of slush. The difficulties of hauling heavy and often top heavy loads through this are indescribable. Possibly it is enough to let these few and quite inadequate illustrations speak for themselves.

The machines for this task of supplying the industries of the north

*Sleigh in broken ice at portage waiting to be pulled out; cable laid out for tractor.*

*Recovering a tractor from bottom of Lac Seul.*

have been thus briefly described. But these would be useless without the kind of men who ride them and service them and direct their movements. It is no job for a weakling. More than just a strong constitution is called for if we who order the shipments out are to feel sure it will be delivered in reasonable time. On occasion the freight may even have to be fished up out of twenty feet of water, and though misdirected and lost a couple of times en route, somehow or other it will ultimately get to its destination. Both industry and the individuals pioneering in the remoter reaches of the province are dependent on and owe much to these men who, as a matter of course in their daily work, face and overcome the worst obstacles that nature can impose in the way of weather and ground. Transportation spells trouble in plenty, but it is, of course, not all bad going, and on many a clear still day, with the far woods sparkling in the frosty air, the engines running well and the sleighs slipping along smoothly, there comes a lightness to the driver's spirit which is seldom attained in other surroundings; a feeling for the moment that he is right on top of the world and all is well with it. Even the crew off duty in the caboose is happy, though it can never be considered that they could traverse the smoothest looking lake, in Kipling's words—"Pleasantly sleeping and unaware". It is true that half of us do not know how the other half live—or work. If the opportunity ever presents itself, take a trip of even ten miles on a tractor train. Spend half the time in the caboose, if you can stand it. It will be an experience long to be remembered.


# Concrete: Its Maintenance and Repair*

By R. B. Young, Testing Engineer, Hydro-Electric Power Commission of Ontario

REPAIRING concrete is somewhat analogous to the treatment of disease. Before remedies can be correctly prescribed, the malady has to be diagnosed and before an accurate diagnosis is possible, the doctor has to have a thorough knowledge of disease, its various symptoms and treatments. The concrete doctor, in his field, needs similar knowledge if the treatments that he prescribes for ailing structures are to be successful, that is, he must know the causes for the deterioration of concrete and the symptoms of each.

There are many symptoms of deterioration that should be noted and evaluated in examining concrete; i.e., ravelling, where and how occurring; cracking, its position, extent, pattern and the presence of deposits therein; deposits of various kinds, both in and on the concrete, their location, kind, and color; the popping or cracking of aggregates; the color, texture, hardness, and ring of the concrete; the condition of the surface, whether it is absorptive, etched or scaled; the relation of deterioration to structural defects, to drainage, to joints, to the way the concrete was placed during construction and many similar conditions that require experience and a trained observation to interpret. Those interested will find information of this kind in papers previously presented to the Institute.

One of the difficulties in diagnosing the ailments of concrete is that they seldom occur singly. If a concrete is susceptible to attack, several agencies

*Presented at 33rd Annual Convention, American Concrete Institute, New York, February 23-26, 1937.

may combine to destroy it. This, of course, adds to the difficulty of diagnosis and in every case, an attempt should be made to determine which are the primary causes of the deterioration and which are secondary or only incidental.

When determining the significance of symptoms, consideration should be given to the age of the concrete and the rate of its deterioration. It is obvious that if concrete only a few years old, is weathering badly, it is more serious than if twenty years had been required to reach the same condition; thus in many cases, the necessity for repairs depends to a large extent on the rate at which the concrete is deteriorating.

As in medicine, so in repairing concrete, the diagnosis should be followed by the selection of suitable remedies and likewise there may be different treatments which will effect a cure. And as in medicine, there are also palliatives and there are cures, there are quack remedies and there are cases where our knowledge is insufficient to prescribe a sure corrective. But unlike medicine, where the patient is not likely to quarrel with the cost of the cure if the results are certain, the treatment of concrete has an economic side that must always be considered.

Maintenance and repair have much in common and in many cases it is difficult to say whether the remedial work being done is one or the other. In any case, the difference is largely one of degree and the methods are essentially the same. But maintenance, as generally understood, is work done during the ordinary course of operating a structure, while repair work involves major restorations requiring that, for prolonged periods, the structure be taken out of service, wholly or in part. In the discussion which follows, no attempt is made to separate the two, for the principles underlying both maintenance and repair work are the same and similar methods and materials are used.

There is no simple classification that can be followed in discussing the various methods used in the maintenance and repair of concrete. For convenience, we will consider them under the headings of surface treatments, waterproofing, pointing and caulking, patching, surfacing with mortar coatings and replacement. These overlap to a considerable extent and some methods may fall within two or more of the classifications, as for example, both caulking and surface treatments are used for waterproofing concrete structures.

By surface treatment is meant the application of some material to a surface as a means of protecting that surface or the body of the concrete behind it from the effects of weathering. These treatments may range all the way from painting to pneumatically applied mortar. They vary greatly in effectiveness and in their useful life.

### PAINTING

Most painting of concrete is done for decorative purposes. This type of maintenance is not within the scope of the paper and those interested will find the subject discussed in the publications of the Institute.[1] Certain types, the asphalt, and cement paints are useful as surface waterproofings

[1]Painting on Concrete Surfaces—Report of Committee 407, Journal, Amer. Concrete Inst., September, 1932. *Proceedings*, Vol. 29, p. 1.

and they will be considered as such. The oil paints are handicapped by their liability to saponification. It is hopeless to apply an oil paint to a surface that is moist or likely later to become moist. Any moisture present in concrete rapidly becomes strongly caustic and very little, if in contact with an oil film, will cause it to saponify. Situations like this may sometimes be taken care of by the use of paints inert to these caustics, but if the paint films are themselves impermeable, they are likely to be pushed off by the moisture from behind. If they are permeable, efflorescence may form which, if it occurs behind the film will also push it off, and there are other difficulties. It is the author's experience, that as a class, paints have a very limited use in preventing the deterioration of concrete. Moreover, the best of paints have a relatively short life, and have to be renewed at frequent intervals to maintain their effectiveness as a protective coating.

Closely allied to the paints, are the surface waterproofings which are of many types. The most commonly met with are the transparent coatings usually consisting of various waxes or metallic soaps dissolved in a suitable solvent. Some are little more than clear varnishes. A few are compounds of iron which on application, are treated with sal ammoniac and a number are solutions or emulsions of asphalt. Some have merit, more have none and the best have to be used wisely for satisfactory results.

### TRANSPARENT WATERPROOFINGS

The theory upon which the claims for the transparent waterproofings are based is sound but, as a class, they are very disappointing. They consist of a waterproofing material dissolved in a volatile solvent by which it is carried into the pores. On evaporation of the solvent, the waterproofing substance is left in the pores and so prevents the entrance of moisture.

Most of the transparent waterproofings, when newly applied, will waterproof concrete but few will continue to do so for more than a few months. Careful experiments planned to simulate natural weathering, were carried out by the Hydro-Electric Power Commission of Ontario some years ago on a group of these transparent and colourless waterproofing materials. Both mortar and concrete specimens were treated as directed by the manufacturers and tested for absorption at intervals up to two years. Parallel tests were run on untreated specimens. Many of the treatments had entirely lost their waterproofing properties in six months and none were of any value after two years. Earlier experiments by the Bureau of Standards gave much the same ressults,[2] while the more recent tests of Jumper, although carried out on a different basis, were equally negative.[3]

It is unfortunate that this is so, for in maintenance work there is a real need for a waterproofing material of this type that can be depended upon to give protection for a reasonable length of time, say from three to five years. The author keeps experimenting with these materials, always hoping that the next tested will be satisfactory but the experience of our

[2]Technologic Paper No. 3, National Bureau of Standards, 1911.
[3]C. H. Jumper—Tests of Integral and Surface Waterproofings for Concrete—Journal, Amer. Concrete Inst., December, 1931. *Proceedings*, Vol. 28, p. 209.

British colleagues over a period of 75 years leaves little basis for this hope.[4]

The waterproofings of the varnish type are, for all practical purposes, paints with all their characteristics and shortcomings. Those that lay claim to deep penetration, approach the transparent waterproofings in their properties and usefulness. In the Commission's experiments, the varnish type of waterproofing has proven, as a class, the poorest of all.

### IRON TREATMENTS

The iron treatments consist of very finely divided iron particles and sal ammoniac applied to a wet surface in the form of a grout. The iron is drawn into the pores of the concrete and changed there by the chemical into iron oxide. Since the iron, oxidizing, increases in volume, it is claimed that the pores of the concrete will be sealed. Jumper's tests would indicate otherwise.[3] The treatments are usually repeated one or more times and followed by a cement and sand wash.

Iron treatments have been known for many years and certain responsible organizations doing repair work use them regularly and, in the face of this, one would be foolish to condemn them. The author has had but limited experience in their use but in so far as they are applied solely as surface waterproofing treatments, his observations lead him to be very doubtful of their efficiency. On the other hand, he has seen some successful repairs in which they were used as a waterproofing and bonding medium under a patch or plaster coating and others where they were used as an admixture. Whether or not the repairs would have been equally successful without, is a moot question which circumstances make it impossible to answer, but as to the success of the repairs, there can be no doubt.

### BITUMINOUS WATERPROOFINGS

The bituminous waterproofings differ from the paints in that the vehicle used evaporates entirely, leaving practically pure asphalt on the treated surface. They fall generally into one of two classes: the solutions or "cutbacks," in which asphalt is dissolved in a petroleum solvent; and the emulsions, in which water is used as a carrier. Asphalt has also been applied hot after being heated to bring it to the proper consistency.

Bituminous waterproofings, where used as paints, have the latter's shortcomings. They do not stand up well if exposed to direct sunlight but they can be protected from its effects by combining with them, asbestos fibre, sand, mica or other reinforcement; or, in the case of the asphalts, by coating them with some sun-resisting paint. They excell the average paint in their resistance to moisture for they are chemically inert to the various solutions ordinarily present in soil, atmosphere or concrete. They are weak mechanically and are unsightly but both of these features can be corrected in part where occasion requires.

At this point, it is well, perhaps, to enunciate a principle underlying the waterproofing of structures. Wherever practicable, the movement of water should be cut off at its source; for example, the logical place to waterproof a retaining wall is on the side next to the ground, a dam on its up-

[4]R. J. Schaffer—The Weathering of Natural Building Stones, Special Report No. 18, 1932. Department of Scientific and Industrial Research, Great Britain.

stream face, a pipe or conduit from the inside. But this is not always possible and one of the most difficult repair problems is to cut off the flow of water effectively where it comes to the surface. In the discussion to follow, the different problems presented by the two cases should be kept in mind.

In considering surface treatments such as we have been discussing, it is evident that little could be expected of them if the surface is under pressure from behind but they might be very effective if they could be used between the surface and the source of moisture. It is because of their ability to maintain their effectiveness in contact with water that makes it possible to use bituminous waterproofings in this way and it is here that they offer their greatest usefulness.

The Hydro-Electric Power Commission, in their maintenance work have, in several instances, used bituminous compounds to waterproof the inside of wheelpits where deterioriation was being caused by the seepage of water through construction joints or porous concrete. The treatments have not always been completely successful but in every case they have proved beneficial and reduced, if they have not entirely stopped, the passage of water. Some of the experience gained in this work may be of value to others.

Both emulsified and cut-back asphalts have been used but to date, the former have given the better results. They have an advantage over the cut-backs because they can be painted on a damp surface,—an important asset in hydro-electric work where it is not always possible to get a plant out of operation long enough to dry out the surfaces to be treated. A disadvantage of the cut-back asphalts is the fumes given off in drying, which in confined spaces proves a burden, if not a menace to the workmen. Whatever type is used, the surfaces to which it is applied, should be cleansed thoroughly and then primed with asphalt, well thinned to give maximum penetration into the pores of the concrete and so provide a mechanical anchorage for succeeding coats. This is followed by two or more coats until a film of sufficient thickness has been obtained; or better, a putty made of asphalt treated with cement or sand may be spread on with a trowel to the desired thickness, usually from $\frac{1}{16}$ to $\frac{1}{8}$ in.

### BITUMINOUS MORTARS

Pure asphalts of the grades used in these treatments, are mechanically weak and if required to bridge cracks or cavities of any size, will punch through under pressure. With emulsified asphalt, this can be overcome by mixing with it portland cement in the form of a grout of creamy consistency. The amount of cement used varies with circumstances but the maximum for satisfactory results is from 10 to 12 lb. per Imperial gallon. If greater mechanical strength is required, sand can be added to the mixture until the desired body is obtained.

The inclusion of cement in emulsified asphalt helps to solidify it by removing the emulsifying water. Where asphalt is used alone to fill a large crack or cavity, it is often found that the surface skins over, leaving the moisture trapped in the interior so that it never sets properly.

The use of cement overcomes this trouble and at the same time, reinforces the coating.

The waterproofing of surfaces to be painted decoratively presents a difficult problem. Experiments by the Commission have failed to find any treatment, except cement plaster, that can be applied on the inside of a damp wall or one that shows dampness intermittently, which will definitely stop the movement of water from the back. The experiments indicated that sealing the surface with a coating chemically inert to the caustic solutions present in the concrete was not sufficient, for even with evaporation cut off, the capillary movements of moisture continued and built up a pressure in the entrapped air. This pressure would either puncture the paint film with a myriad of minute holes, thus permitting movements of moisture as before, or, in the case of some of the asphalts, cause them to blister. The remarkable thing about these blisters was that the asphalt film was actually split, with one part remaining fast to the surface of the concrete, showing that the strength of the bond exceeded the tensile strength of the film. Iron treatments had little effect in sealing the surface, the only difference being that the paints did not fail so quickly as on untreated concrete. Some success was had using special paints with a rubber base, but for severe conditions the only remedy found entirely satisfactory was to apply a cement mortar plaster to the surface prior to painting.

Where conditions are favourable, a very satisfactory method of waterproofing concrete surfaces is by the use of a plaster coat of cement mortar. It cannot be applied in locations where there is active seepage, unless the seepage is collected and drained away. Well applied, it should withstand considerable pressure once it has set, so that frequently the drainage system put in during application can be plugged. The success of any plaster job depends on the preparation of the surface, the way the mortar is applied and its subsequent curing, and it is useless to put any but experienced men on this class of work.

The Commission has used cement mortar in this way with entire success. One job in particular was a very wet underground tunnel that had to be used as a passageway. It was waterproofed with cement mortar and after a period of curing was decorated with an oil paint. No difficulty from saponification was experienced.

A difficult waterproofing problem is to prevent moisture passing through cracks from the outside to the inside of a thin concrete, gunite or plastered wall. If the cracks are structural, of appreciable width and few in number, the most satisfactory way is to groove, caulk and point them. Where they are numerous, such as shrinkage cracks over the reinforcement in a thin wall, it is impracticable to treat them in this way. Here a coating of cement paint will frequently seal the cracks, or the same result can be had by using raw linseed oil. The linseed oil has the advantage that no curing or after treatment is required, as with the cement paint, but it will give a yellowish cast to the surface for a time. It will have to be repeated

periodically, say every three to five years and it is only applicable to walls that are normally dry and not in contact with the ground or other continuous source of moisture. Where it can be used it is very effective.

It might seem that the use of linseed oil as recommended here, is inconsistent with the previous statements regarding transparent waterproofings. It is probable that some of the commercial waterproofings would be satisfactory if used in this way, but they are more costly. Why linseed oil has proved so satisfactory is a matter of speculation. In the author's opinion, it is because of its great penetrating power. It goes deep into the cracks, it contains nothing to be filtered out in its passage and once in the concrete, it either sets up and fills the crack or, if it should saponify, the soaps formed act as a seal.

Raw and not boiled linseed oil should be used for this work. Boiled oil is more viscous does not penetrate as deeply and leaves an unsightly surface. Boiled oil is, however, frequently recommended as a sealing coat where the surface is later to be painted.

The passage of water through construction joints and structural cracks, especially if it is under pressure, is another problem of great difficulty. The logical place to stop a flow of water is at its source but it is not always practicable to unwater a structure to do this and even if it is, it still may be impossible to determine exactly where the flow originates. This is particularly true where there are intersecting vertical and horizontal joints, for one may feed the other, and the water may and often is travelling long distances before it appears at a surface. A further complication results where there are structural movements at the joint to be waterproofed.

### Caulking

Many methods have been tried in an attempt to solve this problem. Where the concrete is not subjected to freezing temperatures and the joints are narrow, seepage can be stopped at its exit from the concrete by caulking. In this case, the first step is to localize the seepage by the installation of a drainage system to collect and remove the water. Then the crack or joint should be channeled or chased and thoroughly cleaned. If the cracks are narrow and can be cut out, they may be caulked with oakum and sealed with either cement or bituminous mortar, but it is a waste of effort to use cement mortar for this purpose if there are structural movements in the concrete. This method is applicable where the seepage is under considerable head and, carefully done, it has been found satisfactory. Frequently, the first attempt at any one point will be unsuccessful, but a skilled and patient workman will ultimately get a job. (Fig. 1).

A variation of this method is to place a little plastic asphalt at the bottom of the channel before the oakum is driven in or to use two layers of oakum with an asphalt ribbon between. The asphalt plastic should be used sparingly, especially if the pointing is done with a bituminous mortar, for there is a tendency, if the repair is liable to summer temperatures, for the oil in the asphalt

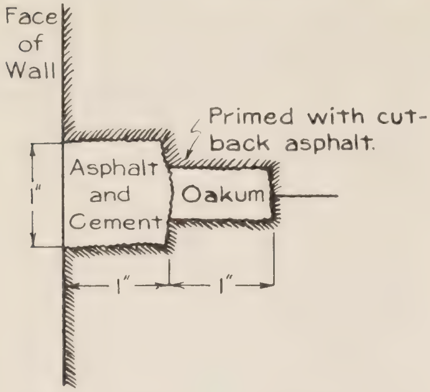



*Fig. 1—Method of caulking cracks against pressure.*

to soften and bleed past the mortar at its contact with the concrete and so loosen the seal.

Proprietary compounds of rubber and asphalt have been used with great success but they are expensive and tricky. They cannot be melted, they must be applied hot and worked into the groove with tools. The surfaces to which they are to bond must be dry, and, for best results, should be primed with a cut-back asphalt.

The same methods are applicable where the seepage is to be cut off at its source but, of course, no drainage is required. In many cases, the oakum may be omitted although its use will result in a more reliable job.

The only sure way of waterproofing seeping cracks or joints exposed to frost, is by cutting the water off at its source. Any drainage system that may be installed will freeze and put pressure on the caulking, and even where the caulking will stand the pressure, it will be forced out by the freezing of water trapped behind it, nor is it practicable to caulk at a depth sufficient to prevent such freezing.

Another reason why this type of repair is not always effective is that, where the seepage exists, there is a tendency for the moisture to spread into the adjacent concrete by capillary action giving a zone of saturated concrete that is susceptible to frost action. If trouble of this type has occurred, the caulking of the joint will not stop the capillary movements of moisture or the deterioration of the concrete.

A simpler problem is the waterproofing of cracks or joints to protect them against the effects of weathering. If there are no structural movements to contend with, they can be grooved and filled with cement mortar, using methods described under patching to insure the bonding of the new concrete to the old and to prevent shrinkage of the mortar from the sides of the groove. Bituminous mortar, roofing plastics or emulsified asphalt may be used for the same purpose but in the case of the latter some difficulty may be experienced where it is subjected to low temperatures since it then becomes brittle. With any of the last three, it is necessary, for best results, to prime the surfaces of the prepared groove with a cut-back or thin emulsified asphalt.

GROUTING

The Commission has experimented with pressure grouting of horizontal joints in gravity walls but the results have not been satisfactory. In the first place, it was found that even with a very thin grout, the cement travelled only a short distance from the grout holes before it filtered out and the hole plugged. It might have been possible to have forced the cement

farther, if higher pressures could have been used, but the latter would have involved the risk of lifting the section of wall above the joint. The method had other disadvantages. Even if a row of holes was grouted to form a watertight zone along the horizontal joint, the intersecting vertical joints, not being watertight, allowed seepage to reach the former back of where it had been sealed. An attempt was made to close the latter by drilling a vertical hole along the joint near the upstream face, which was to be filled with asphalt, but if there were any difference in the hardness of the concrete on either side of the joint, the hole could not be drilled straight and the attempt would have to be abandoned.

### Patching and Plastering

Patching, in the sense that it is used in this paper, refers to the replacement of small areas or volume of concrete. Ignoring for the moment the preparation of the area to be treated, the success of any patch will depend largely on overcoming the tendency of the concrete to shrink after placement, and on securing a bond to the parent concrete.

Many methods of patching, claimed to overcome the twin evils of shrinkage and poor bond, have been put forward from time to time and almost every cement worker will have some way that he claims will absolutely assure success. In so far as the first is concerned, preshrinkage of the mortar has been found very effective. This is done by mixing it well ahead of use and letting it stand. The time required to obtain the necessary shrinkage varies with different cements, temperatures and mixes, and can best be determined by experiment. Once shrunk, the mortar should be used without the further addition of water.

There are on the market materials, which when added to mortar or concrete, are claimed to counteract the effects of shrinkage. The author has examined several jobs in which they were used. With some, no cleavage between the mortar and the old concrete was found and the patch was tight; but with others using the same admixtures, it was observed that shrinkage had not been entirely eliminated and the patch had pulled away slightly from the parent concrete. As a whole, the results observed were no more satisfactory than those obtained by preshrinking the mortar.

There are several ways of insuring a good bond between the patch and the parent concrete. One frequently used, is to sprinkle dry cement on the wetted surface just before applying the patch material; another, is to throw the mortar forcibly onto the prewet concrete. Whatever the system used, the important thing is to get an intimate contact between the new and the old materials throughout the area to be patched.

The method of bonding most favoured in the Commission's work, is to prepare the surface by brushing in successive coats of a thick cement grout. Each coat is allowed to dry until it becomes tacky to the touch before the next is applied. From three to five applications of grout are used, followed by the patch material well trowelled into place. This method is slow but it gets results and, where

the colour of the patch and the concrete are matched, patches can be made thereby that will almost defy detection.

If unsightly patches are to be avoided, it is necessary to match their colour to the concrete. If the aggregates and the cement in the two are similar, this may easily be done by using the same proportion of each as was used originally. If different materials have to be used, some experimentation will be necessary to get the same colour after the patch has dried out.

Finally, the patch should be thoroughly cured by keeping it covered with a damp cloth or otherwise wet for several days after being placed. Neglect of this simple precaution will defeat all the care taken in the preparation and workmanship. This cannot be emphasized too strongly.

Patching over large areas of shallow depth would be described more properly as plastering. In these cases the same methods apply as were described for patching. Surfacing to an average depth of approximately one inch and less has been done successfully, following the method of the Commission. However, unless skilled workmanship is used, the results are likely to be disappointing and the author does not advocate plastering for the restoration of surfaces, if it can be avoided.

An important factor in the success of patching is the preparation of the area or cavity to be restored. All loose and decayed material should be removed, the edges of the patch should be trimmed vertically to the surface or slightly undercut, and the surface of the concrete should be thoroughly cleaned of all dust and loose material by flushing with water. If compressed air is available, it may be used to advantage in addition to the water for cleaning the surface. The area to be treated should be well soaked a short time before applying the concrete but there should be no pools of standing water or excess moisture present when the patch material is placed and, while the surface should be wet, some of the natural suction of the old concrete should remain.

Where large areas or masses are to be restored or protected, the methods so far described are no longer adequate and the operation becomes essentially a major repair. Work of this kind requires not only the restoration and protection of the concrete and the removal of the causes for the deterioration but, frequently, the strengthening of the structure or the making of alterations thereto. It is not the purpose of this paper to consider the latter type of work, except to indicate that sometimes it is the governing factor in any decision as to methods to be adopted in making repairs.

Practically speaking, there is a choice of but two methods for the restoration and protection of large masses of concrete. The one, is to use reinforced mortar, pneumatically applied; and the other, ordinary concrete made, placed, and cured according to standard practice. The two may be used in combination on one job, but they remain distinctly different methods of treatment.

### Pneumatically Applied Mortar

Pneumatically applied mortar has been used for the repair of concrete

for many years and on a variety of structures, and is a recognized method of repair. It has the advantage of being easily applied over large areas and to require but a limited amount of equipment. It has the disadvantage of having to be put on in thin layers and, if there is any depth to be built up, it requires many successive applications to complete the job. It has the further disadvantage that it has to be applied with great skill and its success is largely dependent on one workman, the nozzle operator. Lamprecht has described in some detail[5] the methods to follow and the precautions to be observed in using pneumatically applied mortar, and they will not be repeated here.

The author has examined many structures where pneumatically applied mortar has been used. Almost without exception the mortar surfaces have been found cracked and, in many cases, carbonate deposits are present, indicating a movement of water through these cracks from behind. However, the direct passage of water through the mortar itself, is conspicuously absent. Where no reinforcement has been used, areas will frequently be observed in which the mortar has spalled from the concrete below or is loose, but there are a few jobs where it is intact and in good shape. Even where the mortar has been reinforced and dowelled according to the best practice and where the job has been well handled, areas of appreciable extent have been found separated from the concrete below.

[5]J. Lamprecht — Concrete Restoration in Water Impounding Structures—Journal, Amer. Concrete Inst., May-June, 1936. *Proceedings*, Vol. 32, p. 532.

Whether or not this lack of bond is due to poor workmanship or some other cause is not entirely clear from the author's observations. At first he was inclined to believe the former, but more recently he has felt that there was a strong possibility that in many cases, the mortar came away from the concrete after the work was completed, for far too many jobs, which had been done by skilled and responsible people and under competent supervision, had this fault. Recently, the Commission used both reinforced and unreinforced mortar applied pneumatically, on two structures and every square foot of each was inspected by tapping with a hammer and found properly bonded. These jobs will be reinspected periodically and if any breaking of the bond is discovered, there will be no question but that it occurred after the concrete went into service.

In the majority of structures examined, pneumatically applied mortar, in spite of its cracks and its occasional lack of bond, may be said to be serving its intended purpose reasonably well. While most of the structures inspected have been less than ten years old in these as yet its faults do not seem to have reduced its effectiveness to any great extent.

### REPLACING WITH CAST CONCRETE

Ordinary concrete offers advantages in many types of repairs and hence is widely used for this purpose. It is particularly applicable where major restorations, additions or changes are to be made. Its use in these cases differs in no way from standard practice. As with any concrete construction, it should be made of sound mate-

rials, correctly proportioned, thoroughly mixed, and it should be handled and placed without segregation. Finally, it is most important that it be properly cured. These requirements and the reasons for them have been discussed so often in the technical literature that they need not be repeated here.

The principal difference between the use of concrete in ordinary construction and in repair work is in the attention that has to be given to the preparation of the concrete to which the new is to be bonded. It is of the utmost importance that all decayed and defective material be removed from the sections to be restored, and that the surfaces be so prepared that the new concrete will knit with the old. In so far as bonding is concerned, the methods described under patching have been found satisfactory, but where it is necessary that the new concrete share the load, it should be reinforced and dowelled to the old to insure their acting as a unit.

### Preparation for Repairs

It is not always easy to determine just how much of the deteriorated concrete needs to be cut away. In many cases, if an attempt were made to remove all material that was in any way weakened, little or none would be left; but where the old concrete is to be encased by the new, it is not necessary that the former should be removed until there is no further evidence of deterioration, provided that all loose material has been eliminated. Where the old and new concretes are to form a junction at a surface exposed to the weather or other adverse condition, it is important that the old concrete be perfectly sound or else it will be found that in a few years, deterioration will have taken place behind the repair. Many instances of this kind may be observed in examining reconditioned structures.

The proper preparation of the old concrete to receive the new is, of course, just as necessary with pneumatically placed mortar as with concrete; but with the former, the problem is more often that of preparing large, rather than local areas. Here again, it does not seem necessary to remove all deteriorated concrete provided the loose and decayed material is eliminated. But a good surface to which to bond the mortar is necessary and should be provided.

A method that has been used by the Commission in preparing plane surfaces of large area, is to chip with a narrow tool, shallow grooves three to four inches apart in both directions after the manner used by stone masons in trimming stone. A narrow chisel is better for the purpose than a broad one. The areas left between the grooves will usually spall as the second series of cuts is made, leaving a fresh surface for the application of the mortar or concrete.

### Eliminating Shrinkage

One of the difficulties met with in casting in a new piece of concrete is to take care of shrinkage and prevent cracks forming between the old and new, especially along the top edge. If the volume of the piece to be cast is not too great so that it is possible to preshrink the concrete as described under patching, little difficulty will be experienced in this connection. If preshrinking is not practicable, the

best way to provide against excessive shrinkage is to have the concrete as dry as it can be placed. This, combined with the proper preparation of the surface and a sufficient period of curing, will usually result in a satisfactory joint.

A method that can sometimes be used where shrinkage has to be absolutely eliminated is to dry-pack using a mortar or concrete of a very low water content. For setting machinery or column bases, for underpinning or similar work, a 1:2 or 1:2½ mortar will be found satisfactory. It should be mixed with just sufficient water to hold it together when tightly squeezed in the hand. This mortar is placed by tamping or ramming vigorously and, of course, it should be thoroughly cured. Concrete can be similarly handled but the general practice of the Commission has been to use cast concrete to within three or four inches of the member to be supported and to dry-pack the space left after the former has sufficiently hardened.

*(To be continued.)*

## Muscle Power vs. Electricity

Pedalling a bicycle in a six-day race appears a most gruelling test of muscle power, yet a single rider, if he were able to keep going day and night without a stop, would exert energy only equivalent to about 25 cents worth of electricity.

This was revealed when some of the racers competing in a six-day race in Madison Square Gardens tested their strength on a special bicycle built to accurately measure the muscle power of the riders. The best record was made by Alfred LeTourner, member of the French team. After hard riding for one minute, he succeeded in generating .0018 kilowatt-hours. Had he continued this pace without a stop for the entire six days, he would have generated 15.55 kilowatt-hours. The best any rider could show on a sprint was enough electricity to light two 100-watt lamps, but none could hold this rate more than five seconds.

The moral is obvious: "Don't use muscle power for your household tasks when electricity can do the job for you, so easily and cheaply."—*Winnipeg Hydro News.*

# "More Than a Light Bill"

MORE people every day are realizing that their electric bill is not just a bill for lighting — more than that, it is a bill for cooking, refrigeration, water heating, house cleaning and many additional conveniences and comforts in the modern home. And when they compare their electric service bill with what it cost them in money, time and labour to do these tasks non-electrically, they all agree that their electric bill, regardless of its amount, represents a saving over previous methods and, moreover, is now the smallest item in the household budget.

Thus when the relative insignificance of the electric bill is taken into consideration, in addition to the high quality of the service received, it is not surprising that the majority of American citizens see no justification for the dither about the so-called high cost of electricity.

Mrs. Ivan L. Bigeler, a customer of the Pacific Gas and Electric Company at 5474 Manilla Avenue, Oakland, California, might well be speaking for the majority of housewives in America when she says:

"My electric bill is not just a light bill. It covers more items for comfortable, healthy and happy living than any other bill we get.

"A few years ago our home was made 'all electric' and now I realize that the electric bill, low as it is, pays for:

"Fast, easy and excellent cooking with a simply-regulated range.

"Heat that is quick, automatically controlled, clean and healthful.

"Refrigeration that's better, surer and more economical than the old type.

"The joy and comfort of abundant hot water at all hours.

"Perfect laundering without work, by means of the washing machine and ironer.

"Housecleaning rapidly and thoroughly done by the vacuum and floor polisher.

"An effortless method of sewing, mending and darning with the modern sewing machine and its many attachments.

"Several attractive appliances that make delightful refreshments for guests.

"Entertainment and amusement via the radio, electric trains and games.

"The accuracy of electric clocks.

"The convenience of heating pads, hair driers, vibrators and many more 'gadgets'.

"And, of course, a lot of light.

"So, considering the matter from every angle, we feel that our electric dollar buys more real service than any dollar we spend." — *Public Service Magazine.*

# Our Satellite, the Moon

THE most friendly of celestial bodies is our Moon, coming around regularly every month and spending two weeks with us in our evening sky on each occasion. It is, of course, the nearest of these bodies and, next to the Sun, the most conspicuous.

Ancient peoples called the moon the "Queen of Heaven" created "to rule the night" and it was considered responsible for the growth of the crops and production of the harvest. The appearance of a new moon was the beginning of a new month and this was a time for offering sacrifices and expecting special blessings.

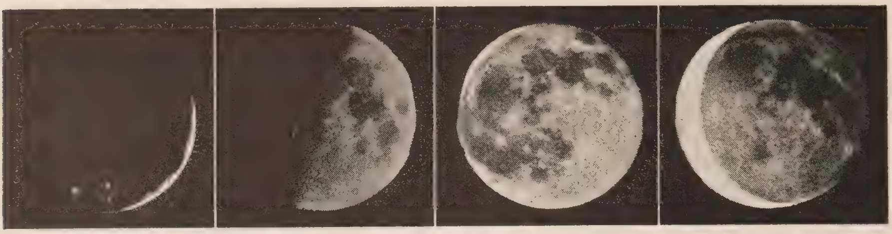
*Fig. 1—"The Man in the Moon." The man supposedly punished with death and deported to the moon for gathering sticks on the Sabbath Day.*

The moon has always been an object of both popular and scientific interest and its rapid movement amongst the stars must have been noticed at a very early date. The dark spots on its surface were thought to be blemishes due to the sins of the people on this earth, and many are the imagined figures formed by these spots,—for example, the face, the cow, the crab, and the lady in the chair. The most popular of these figures, however, was "the Man in the Moon," Fig. 1,—the man who was punished with death for gathering sticks on the Sabbath Day (Numbers 15:32) and sent to the Moon where the inhabitants of the earth could look at him forever.

The moon has a diameter of 2,160 miles and appears practically spherical. Its distance from the earth varies from 222,000 to 253,000 miles, and it makes a complete revolution around the earth in one sidereal month,—an average period of 27 days, 7 hours, 43 minutes, 11.5 seconds. Its orbit is inclined 5°-9′ to the plane of the earth's orbit.

The synodic, or lunar month,—from new moon to new moon,—is somewhat longer than the sidereal month, however, for while the moon is revolving around the earth, our planet itself is moving forward on its orbit and the moon then must make about 390 degrees of revolution, instead of only 360 degrees, from any phase until it returns to the same phase again. The lunar month, therefore, has an average length of 29 days, 12 hours, 44 minutes, 2.8 seconds.

The phases of the moon, Fig. 2, are most striking and add variety to the appearance of our satellite as there is a change from each night to the next. After conjunction with the



*a* *b* *c* *d*

*Fig. 2*

*a. The new moon, showing sharp horns or cusps.*

*b. The first quarter moon, seven days old.*

*c. The full moon, showing the dark spots.*

*d. The old moon, the darker part being illuminated by sunlight reflected from the earth's surface.*

sun,—passing the sun,—there is first the new moon, the thin crescent with sharp horns, or cusps, Fig. 2a, which appears in the western sky just after sunset. It grows thicker, without any appreciable change in diameter, until it is a half disc, the "first quarter" or seven-day-old moon, Fig. 2b. It is now in the southern sky but continues increasing, through the "gibbous" or bulged phases, until it becomes full, Fig. 2c, and rises in the east as the sun sets in the west. After this, it decreases through the gibbous phases, but with the bulged side facing east, instead of west, and on through the decrescent phases, Fig. 2d, to again become a new moon a few days later.

When very new, or very old, the outline of the whole moon and some dark spots may often be seen, Fig. 2d. Here the surface, other than the crescent, is illuminated by sunlight which has been reflected from the earth's surface. This then is known as the "earth-lit" moon.

As the period of rotation of the moon on its axis is precisely the same as its period of revolution around the earth: a remarkable coincidence, it always presents the same side to our view. Some minor variations, known as "librations", are observed, however, as the moon appears to be oscillating slightly, first showing a little more at one edge and then more at the other, but this phenomenon is apparent only for the rate of rotation is constant. The illusion is due to the varying velocity of travel of the moon on its orbit and also to the inclination of its axis.

There is forty-one percent of the moon's surface which is always facing the earth and can be seen if illuminated. An equal area on the far side is never seen from the earth. The remaining eighteen percent of the surface appears intermittently as the result of the librations.

The moon has little or no atmosphere; no clouds appear and there are no refractive effects,—colour changes or apparent delay in motion of a star as it disappears at the moon's edge. For this reason too, surface details of the moon can be

*Fig. 3—The northern part of the moon showing craters and mountain ranges, and also plains which were thought to be seas.*

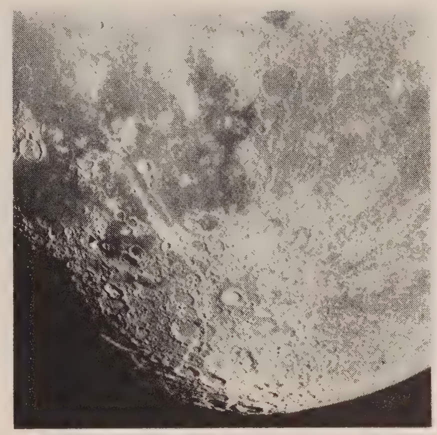


*Fig. 5—The southern part of the moon showing a confusion of craters, including Tycho which is the centre of a system of rays giving the moon the appearance of an orange.*

*Fig. 4—The crater Copernicus, 56 miles wide, and surrounding region.*

quite clearly seen and there appear to be many mountains and volcano craters, Figs. 3, 4 and 5. Several craters evidently are about the same size, 50-60 miles in diameter, but others are as wide as 140 miles. Some of the mountains are as much as 16,000 ft. high. A few cracks and crevices also are observed.

These formations which appear as craters are subjects of considerable conjecture. How were they formed? If actually volcanos, then how can their great size be explained? On the other hand, possibly large meteors have struck the moon when it was in a plastic state and these, while burying themselves, would cause the rings which have now solidified. This may be the explanation, but if so, it is difficult to understand how these meteors have all met the moon radially. Only in a very few locations is there evidence of meteors having struck tangentially.

*Fig. 6—The moon entering the earth's shadow at the beginning of a total eclipse,—a series of photographs, left to right, taken at five minute intervals.*

The moon is a dead body; no changes in surface features have ever been noted and it apparently is entirely devoid of life of any kind. Being a small body, the gravitational attraction at the surface is small,—about one-sixth of the attraction at the earth's surface. The moon makes its influence felt on the earth, however, for it is the controlling force in the generation of the tides,* and also, the position of the moon must be taken into account in the adjusting of very high grade chronometers.

As the chief actor in both solar and lunar eclipses,† the moon arouses fears in the superstitious, is enshrouded in mystery for the multitudes of interested observers, and provides welcome diversion to the astronomers.

*Tides and Tidal Rivers. Bulletin, April, 1938, page 147.

†Celestial Eclipses, Bulletin, June, 1935, page 187.

There are many lunar myths but not much foundation for them. There is, for example, no support for the thought that the moon's phases affect the weather or crops, or that "wet" and "dry" new moons,—according as the moon by its inclination would, or would not, "hold water,"—bring corresponding conditions, for the position of the horns of the moon can be predicted through a thousand years to come but no one can foretell the weather even a week ahead. Nevertheless, we hear that "sharp horns do threaten windy weather," that the times of new or full moon are "most favorable" for commencing a new business enterprise and that it is "unlucky" to first observe a new moon through glass,—and we disregard these sayings, but nothing harmful seems to happen.—*F.K.D.*

# Safety in Electrical Test Departments

ON account of a fatal accident which occurred comparatively recently on the electrical test floor of a manufacturer of power equipment in the Province of Ontario and considering the recommendations of the Coroner's jury on this case, the Inspection Department and Laboratories have studied conditions found in several such test departments and have prepared the following set of rules to promote greater safety in testing electrical equipment. Manufacturers of electrical devices, power equipment, cables and conductors, who do electrical testing, and also shops which repair and test such equipment are asked to give these rules a thorough trial for a period of six months and then to submit to the Commission any comments or criticism which they may have regarding either the rules or their application.

### General Rules For Safety In Electrical Test Departments

1. Each test shall be conducted under the definite supervision of one man, who shall be appointed by, and responsible to the test foreman, and shall be thoroughly familiar with the test circuits and methods of test. He shall assign duties to the other testmen, inspect circuits and connections, and also know where all other testmen are located and warn them of conditions affecting safety, before any test circuits are made alive. He shall be accountable for the safety of both personnel and equipment during the test.

   Any testman, leaving the test area while a test is in progress, and later returning thereto, shall not take further part in such test until he has reported to the testman-in-charge and has been advised that it is safe for him to proceed.
2. There shall be a system of signals, thoroughly understood by all testmen, and such signals shall be used only in the conducting of tests. Test circuits shall be made alive only by, or on the proper signal from, the testman in charge of the particular test.
3. The boundaries of test floors shall be marked off by walls, partitions or permanent fences, with possibly some temporary fences also, all fences to be painted bright red as warning of a danger zone and, in addition, red lamps mounted on these fences, preferably near the entrances, shall be lighted while any tests are being conducted on the test floors. As further precautions, doors, gates, etc., by which employees would enter the test floors, shall be locked, or otherwise kept securely closed or guarded while electrical tests are in progress, and "Danger" signs shall be conspicuously displayed.
4. The arrangement of test panels, tables and equipment being tested

shall be such that the control switches are visible from the equipment under test and also that that equipment is easily within sight of the testman standing at the test panel, and not behind his back, as he prepares to read the measuring instruments. Adequate space shall be provided around testing equipment, and also around equipment which is being tested. Switches controlling test circuits shall be of suitable types.

5. All test equipment shall be grounded in accordance with the requirements of the Canadian Electrical Code and also equipment under test shall have metal frames well grounded in accordance with good grounding practice. Testing equipment shall be properly protected and carefully maintained in safe condition, and no part of the active test floor shall be used as a storage area for small test equipment. Test leads shall be disconnected from terminals and be cleared from the test floor as soon as tests are completed.

6. An approved method of resuscitation from electric shock shall be practised periodically by all testmen under a qualified instructor.

## From John Wesley's Journal, Saturday, February 17, 1753

From Dr. Franklin's letters I learned:

1. That electrical fire (or aether) is a species of fire infinitely finer than any other yet known.
2. That it is diffused and in nearly equal proportions, through almost all substances.
3. That as long as it is thus diffused it has no discernible effect.
4. That if any quantity of it be collected together, whether by art or nature, it then becomes visible in the form of fire and inexpressibly powerful.
5. That it is essentially different from the light of the sun, for it pervades a thousand bodies which light cannot penetrate and yet cannot penetrate glass, which light pervades so freely.
6. That lightning is no other than electrical fire collected by one or more clouds.
7. That all the effects of lightning may be performed by the artificial electric fire.
8. That anything pointed as a spire or tree attracts the lightning just as a needle does the electrical fire.
9. That the electrical fire discharged on a rat or a fowl will kill it instantly, but discharged on one dipped in water, will slide off and do it no hurt at all. In like manner, the lightning which will kill a man in a moment will not hurt him if he be thoroughly wet.

What an amazing scene is here opened for after ages to improve upon.

## Carl Kranz — Kitchener

Carl Kranz, former Mayor of Kitchener and a member of the Kitchener Public Utilities' Commission for twenty-four years, died suddenly following a heart attack, on Tuesday, May 3rd, 1938, aged 68 years. In the death of Mr. Kranz, Kitchener has lost one of its outstanding citizens who gave many years of public service to the community.

Mr. Kranz was a native of Kitchener, and spent his early life working in his father's store, where he became interested in the fire insurance business. Later he severed his store connections and established an insurance agency which developed into a well-known business and operated under the name of Carl Kranz Limited. For many years he was a director of the Economical Mutual Fire Insurance Company, being vice-president at the time of his death.

In 1902 he entered the Town Council and after serving two years as alderman became mayor in 1904 and 1905. He was deeply interested in the movement that led to the municipality taking over the electric and gas plants about 35 years ago. He was elected to the Public Utilities Commission in 1913, where he served continuously to the end of 1932. In 1935 and 1936 he returned to the Commission, making, in three periods, a total of service on the Commission of twenty-four years.

Besides his associations in the insurance business and municipal affairs, Mr. Kranz was vice-president of the Blue Top Brewing Company, Limited, and vice-president of the Tavistock Milling Company, Limited. He was actively interested in music and sports and took part in the work of a number of benevolent societies.

Surviving him are his widow, one daughter and three grand-children; and also one brother and one sister.

# O. M. E. A. and A. M. E. U. Convention

## At Bigwin Inn, Muskoka
## On July 5th and 6th, 1938

Convention Sessions to be held jointly by the two Associations.

### TUESDAY, JULY 5th, AT 9.30 A.M.

"Load Building"—Addresses by one of the Commissioners of the Hydro-Electric Power Commission of Ontario, and by J. W. Sanger, Chief Engineer, City of Winnipeg Municipal Hydro-Electric System.

### Evening at 6.30

Convention Dinner Address: "Some of my experiences in the Frozen North" (illustrated), by M. A. Mahoney, Ottawa.

### WEDNESDAY, JULY 6th, AT 9.30 A.M.

Paper—"Metering," by E. G. Ratz, Meter and Relay Engineer, Canadian Westinghouse Company, Limited, Hamilton.

Paper—"CBL Transmitter at Hornby, Ont." by a representative of the Canadian Broadcasting Corporation.

Paper—"Electricity on the Highway" by R. E. Jones, Assistant Engineer, Distribution Section, Electrical Engineering Department, Hydro-Electric Power Commission of Ontario, Toronto.

### A.M.E.U. Accounting Session
### WEDNESDAY, JULY 6th, AT 7.30 A.M.

Breakfast meeting arranged by the Committee on Accounting and Office Administration.

### HOTEL RATES

First and Second Floor Rooms, $7.00 per day per person.
Third Floor West (baths) $6.00 per day per person.
Third Floor East (no baths) $5.50 per day per person.
Ferry charge 25 cents return. Garage fee 50 cents per night. Free parking.
If Delegates arrive early, these rates in force from Sunday, July 3rd.

ENTERTAINMENT FOR THE LADIES — GOLF, TENNIS AND BOWLING FREE

# THE BULLETIN

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HYDRO-ELECTRIC POWER COMMISSION
of Ontario

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Per Year

*Ontario Power Plant during the January, 1938, ice blockade.*

JUNE, 1938

# The Rehabilitation of the Ontario Power Plant of the Hydro-Electric Power Commission of Ontario

By Engineers of the Operating Department, H.E.P.C. of Ont.

ON January 26, 1938, the worst ice blockade of which there is any record occurred in the Niagara river between the Falls View bridge and the falls. The ice and water rose to a height of 50 ft. above its normal elevation and inundated the Ontario Power Plant, a 180,000 h.p. development, of the Hydro-Electric Power Commission of Ontario, with devastating effect. A mixture of ice and water which entered the building by the upstream windows and the air intake of the powerhouse flowed into the plant, submerging all equipment located below the level of the crane rail. Twenty-four hours later the river level had receded sufficiently to permit the water to be drained from the building leaving in its wake about 7,000 tons of ice in the form of a tremendous

*Fig. 1—The interior of the powerhouse, facing the down-stream end, after the water had receded.*

## CONTENTS

Vol. XXV No. 6
June, 1938



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

wedge, the full width of the powerhouse, thirty feet high on the upstream, or south end, tapering to practically nothing at the downstream, or north end. (Fig. 1).

While the water was in the building, some 15,000 gallons of oil from the bearings, the governor pressure system, and the transformers rose to the surface and, as the water receded, was deposited over everything which had been submerged.

The first task under the plan for rehabilitation was to provide for the ingress and egress of trucks, as the ice jam had completely blocked the only means of access to the plant; viz., the road which extends from the park elevation down the side of the cliff to the level of the powerhouse main floor at the north end of the building. An entrance was effected by means of a large drag line shovel which was used to excavate a cut through the ice blocade wide enough to permit trucks to pass to and from the powerhouse.

As soon as the road to the powerhouse had been cleared, a ½ ton gasoline-driven shovel was moved in and the removal of ice was begun. Later, another shovel and more trucks were added. The ice which had lodged in the building consisted of fragments about 6 in. thick and under the effect of colder weather following the flood it had frozen into a comparatively solid mass. This condition, together with the added hazard of working around buried generators, governors, and auxiliary apparatus made the digging difficult. Moreover, the floor areas free of machinery were relatively small, making the shovel operations awkward, requiring extraordinary care to avoid damaging apparatus, and necessitating the careful dispatching of trucks to prevent traffic congestion. Some of the areas containing a large volume of ice were so narrow as to prohibit the use of shovels. This problem was solved, however, by making use of an endless belt conveyor to lift the ice up to the window openings and discharge it into the river. All told, some 7,000 tons of compacted ice had to be removed by these methods before attention could be given to the buried apparatus.

The auxiliary equipment received first attention in order to obtain power for crane service, heating and lighting. Early attempts to dry motors and transformers by housing

them in and circulating hot air around them proved that it was going to be a slow job with rather uncertain results and it was deemed necessary to develop some faster and more promising method for the work.

From a discarded 4 ft. diameter oil receptacle, a vacuum tank was made and fitted with suitable heaters and a vacuum pump. The experience gained with this make-shift device demonstrated that the method dried out the apparatus in a matter of hours as compared with weeks under the hot air method and gave convincing proof of the more or less complete removal of moisture, as indicated by the highly satisfactory insulation resistance values obtained. After considering the importance, the amount, and the size of the auxiliary apparatus, it was decided that additional drying equipment, which would not only increase production but which would also accommodate larger apparatus than this small tank, was required for the drying process. Further, the labor cost of operating the equipment for the vacuum drying process, would be materially reduced per reconditioned piece as the labour involved would not increase proportionally with the added drying capacity.

It was decided to design and make two new tanks, 7 ft. diameter and 7 ft. high, which, as later experience proved, made very satisfactory drying chambers. These tanks were constructed similar to a diving bell with a dome-shaped top and a flat reinforced base. The cover or bell was lowered over the loaded steel base and its weight was sufficient to maintain an air-tight joint for the vacuum. A seal, consisting of a ring of standard ½ in. smooth garden hose was found quite satisfactory. As all external connections, such as piping for the vacuum pump, electrical connections for heater supply, and leads for measuring temperature and insulation resistance, pass through the base which remains on the floor, the time required for loading and unloading the tank was reduced to a minimum.

By means of this drying plant there were satisfactorily dried some 100 motors, ranging from 250 h.p. down to small oil switch motors, of voltages from 2,200 down 220. Seventeen exciter sets, consisting of 90 to 185 h.p., 2,200 volt motors and 60 to 125 kw., 250 volt d.c. generators were dried out in 36 to 40 hours per charge of the vacuum tank. There were also dried over one hundred auto-starters, instrument and service transformers, from 12 kv. to 220 volts which required 40 to 48 hours in the tank. These all withstood a double operating voltage test and were restored to service. All the main unit field pole windings that had to be removed for repairs were likewise dried in these tanks. Miscellaneous apparatus such as oil switch liners, rods, solenoids, relays and meters, whose numbers got beyond count were dried out very rapidly under the vacuum process.

As soon as conditions permitted, the job of reconditioning the fifteen main units was started. Prior to the flooding of the plant, the replacement of the stator winding on one of these units had been anticipated because of its weakened condition and its age. As the necessary winding had been purchased already, it was installed without delay, no attempt being made to dry out the generator.

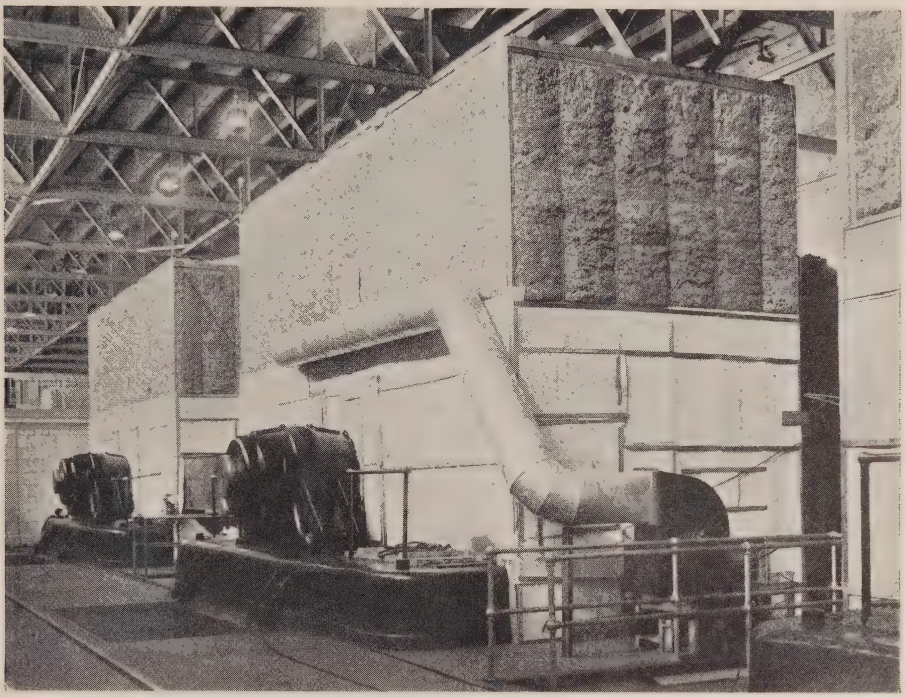


*Fig. 2—The hot air circulating system.*

Of the remaining machines, those which were not embedded in ice were given first attention. The main bearings were flushed out and supplied with new oil. The generator windings were washed down with a mixture of mineral spirits and carbon tetrachloride applied by a spray gun. This was necessary to remove the accumulation of lubricating oil which had been left on the windings at the time the water receded. The hand-taped end connections on the coil ends were removed as they were found to have absorbed a great deal of water and it was also thought the open coil ends would facilitate the removal of moisture.

Casings were then made up of 2 by 4 in. wood frames, covered on the inside with ⅜ in. standard wall board, to completely enclose the generator with the exception of its bearings. On the outside and between the 4 in. studding, four inches of rock wool was placed to minimize heat losses.

Improvised electric heaters of approximately 125 kw. capacity, made by coiling ⅜ by ¼ in. band iron and mounting on suitable insulators were installed in a sheet iron enclosure. A 4,000 cu. ft. per minute fan was installed on one end of this enclosure blowing in cold air which passed over the heaters, raising the air temperature from approximately 8 to 10 deg. cent. up to 120 to 125 deg. cent. By means of an 18-in. circular pipe, this heated air was carried inside the casing which had been equipped with suitably located and adjustable vents

to provide for temperature adjustments as required. See Fig. 2.

Each generator was equipped with a number of thermocouples and from the information thus made available, adjustments and changes were made in the heat circulating system to secure a nearly uniform temperature on all coils.

It was realized early that the insulation resistance to ground in the stator coils was not a reliable indication of dryness. Insulation resistance to ground of higher values than those required for operation were obtained after a short time but the insulation resistance between turns inside the coil was an unknown quantity. In order to obtain some knowledge of the internal condition of the insulation, it was thought that a comparison between the humidity of the ingoing air and that of the outgoing air would give some information that would assist in determining the drying progress; at least such a comparison would indicate no further absorption of water by the drying air which could be interpreted as either that the machine was dry or that the drying method was unsatisfactory.

To obtain these data, wet and dry thermocouples, (simulating the usual wet and dry bulb thermometer method of determining the relative humidity of the air) were installed in the ingoing and outgoing air ducts. However, further consideration of this method of measuring the humidity led to the belief that the data obtained were unreliable because of the wet thermocouple being in a high velocity air duct, and because of the large difference in temperature between the ingoing and outgoing air.

Since the essential information required was the amount of water absorbed by a known quantity of air in passing through the machine, it was felt that this could be determined accurately by measuring the temperature of the dew point of the ingoing and the outgoing air and computing the quantity of water removed per hour per pound of air from these measurable factors.

To obtain the dew point temperature, a home-made device was constructed by using a 5 gal. oil can, fitted with a window, as a "still" case in which was placed a chromium plated, graduated brass tube. This tube had a built-in thermocouple which in turn was connected to a temperature indicating instrument. The tube is so constructed that ice cooled water can be passed through it. To ensure accurate reading of the dew point temperature, the chromium plated tube is marked with thin wax pencil lines every 1/8 inch along its length. These lines aid in the reading because when the tube becomes fogged they remain bright, standing out very clearly like an etched scale.

To use this assembly a funnel ended tube is inserted in the air stream and a small quantity of air is continuously drawn through the "still". When the dew point temperature is to be observed, ice-water is allowed to flow slowly through the tube from top to bottom, thereby cooling it gradually until fogging, from the top downward, due to the condensation of moisture on its surface, occurs. When the fogging has progressed to the thermocouple section, the temperature is read which gives very exactly the dew point temperature of the air sample.

The dew point temperatures of the ingoing air and the outgoing air are both obtained and knowing these, the number of grains of water per pound of air is obtained from a psychrometric curve. Then, by subtracting the moisture content of the ingoing air from the moisture content of the outgoing air, a difference representing the amount of water being evaporated from the windings is obtained. As much as 20 lb. of water per hour was obtained at the start of the drying of some units, but the average was approximately 5 lb. per hour during the early stages of the dry out period.

With all the apparatus ready for service, the drying procedure is as follows: The electric heaters and fans are placed in service with the rotor at rest and the temperature of the unit is gradually raised to 80 to 85 deg. cent. This procedure continues until it is thought the field insulation has dried sufficiently and become firm enough to resist the crushing effect of centrifugal force when the machine is rotating. The next step is to run the rotor at low speed in this hot atmosphere until a minimum insulation resistance of 200,000 ohms to ground is obtained on the field circuit. Sufficient d.c. current is then applied to produce any desired current (up to full load) in the stator windings, when short circuited. During this transfer from the external to the internal heating source, the external heat is gradually reduced, to limit the coil temperature to 85 deg. cent. The operation of the fan, however, is continued at full capacity to maintain a flow of relatively dry air through the housing. This schedule is maintained as long as the air samples indicate that moisture is being carried off. When several successive daily readings show no difference between the moisture content of the ingoing and that of the outgoing air, and the megger readings are constant from day to day, yet too low for service requirements, it becomes necessary to resort to a different procedure.

The final operating schedule of the dry-out is based on the theory that after all parts of the coil insulation have reached a constant temperature there still remains in it a slight amount of moisture which can be removed only by establishing a temperature gradient through the coil insulation. At this juncture the temperature of the interior of the coil cannot be raised higher because of the possibility of damaging the insulation. Therefore, the machine is cooled off as rapidly as possible, thus reducing the temperature of the outside layers of the coil insulation more rapidly than that of the inside layers. While the temperature change is taking place, the small amount of moisture which is present is redistributed through the insulation as it approaches a uniform temperature. In order to expel this moisture it is necessary to again establish a temperature gradient by applying current to the windings. This cycle, which requires about 12 hours for the cooling down process and from 36 to 48 hours to re-establish a uniform temperature, is repeated until the insulation resistance (20 to 30 megohms at 75 deg. cent.) indicates that the windings are ready for service. Before the units were placed into service, a 25 cycle high potential test was made by applying 4,000 volts, 8,000 volts and finally

10,000 volts for 1 minute and measuring the leakage current of each step as a precautionary measure against damaging the winding.

The drying treatment as described, which required from two to three months to complete, was applied to 1—15,000 and 7—8,770 kv-a., 12 kv. generators. Of these, five are completed, two being in service and the others are nearing completion.

Certain other equipment, consisting of 2—1,500 kv-a., 2,200 volt a.c. generators, 2—1,500 h.p., 2,200 volt motors, and 2—375 kw., 250 volt d.c. generators were dried out by means of the circulating hot-air method. This method was deemed to be appropriate because the windings of the apparatus are of the open-slot type and the coils had been formed and impregnated in the factory. Examination had indicated that when the hand-taped end connections were removed, the coil insulation was only moist. Hence, it was concluded that they could be dried satisfactorily.

The other seven main units, consisting of 3—7,500 kv-a. and 4—8,770 kv-a., 12 kv. generators are of the semi-closed slot design. The installation of such a type requires one end of each coil to be made up by hand after the coil is inserted in the slot. Hence, it was thought that this type of winding had absorbed a larger quantity of water than the open-slot type and that because of its construction, greater difficulty would be encountered in removing the moisture. Besides, this group had been completely buried in ice for a considerable time. One coil was removed for inspection and the belief that it would be found saturated was confirmed; when the coil was untaped, water actually dripped out of it and free water was observed between the layers of insulation. These machines had been submerged in 1909 in a similar flood and all attempts to dry them were unsuccessful at that time. Consequently, it was felt that some other method than that used for drying out the open slot machines must be devised, or that the machines of the closed slot type would have to be completely rewound.

From experience gained in the small vacuum tanks, it seemed apparent that if the same method could be applied to the closed slot group of generators, they could be successfully dried out. As the rotors are approximately 17 ft. diameter and a complete generator weighs over 100 tons, the application of the vacuum tank method required some special design features. To completely enclose the generator would require a large amount of material and the solution of some difficult assembly problems. Moreover, it was deemed desirable to design an enclosure which could be used on all main units in the plant, with a minimum loss of time and at reasonable cost.

It was finally decided to design an enclosure that would utilize the stator frame as part of the vacuum chamber. This was accomplished by fabricating ⅜ in. rolled steel sectional end-plates, which were attached to each end of the stator, to form part of the air-tight casing for the generator winding. Each of these fabricated end-plates consisted of a cylinder, long enough to project over the end turns of the winding and of suitable diameter to permit using the end-

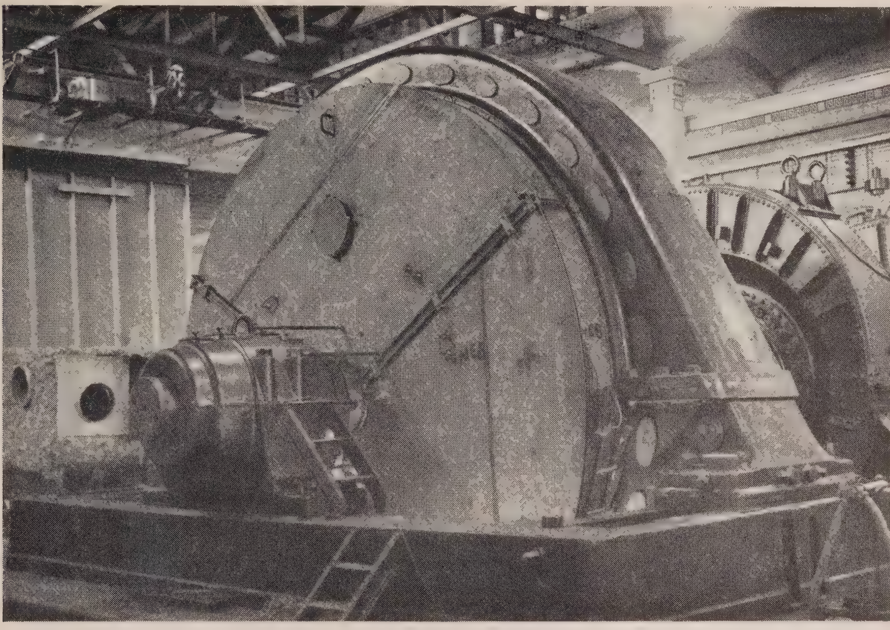


*Fig. 3—The air-tight metal casing.*

bell bolts to attach it, together with three 120° sectors extending radially from this cylinder to the shaft where they were fitted to it. See Fig. 3. Between the plates which were mounted on both ends of the stator, internal cylinders and pipe braces were installed to prevent the collapse of the relatively light material under the pressure, as shown in Fig. 4. To seal the various joints, ½ in. smooth garden hose and special flat rubber, painted with Glyptal, were used. The ventilating openings in stator frame were blocked with small castings and made tight by drawing these castings down on soft rubber gaskets. The split in the frame and the space around bolts and other small cracks were sealed with friction tape and a covering of caulking material.

This assembled tank or vacuum chamber, which readily sustained a vacuum of 26 in. (the limit of the pumping equipment), was connected to the intake side of an air compressor. In the air line from the pump to the vacuum chamber was installed a water-cooled condenser and sump tank to catch the water removed from the generator, thus preventing it from getting into the compressor and causing damage. The sump also provided a means of measuring the water removed, thereby making it possible to determine when the generator was dry.

The procedure which was followed in drying out the main units under the vacuum method is as follows: After testing the vacuum chamber (Fig. 3) for tightness, it is enclosed in a wall board casing similar to that used in the ordinary heating method (Fig. 2). This provides part of the heating system, and, at a later stage

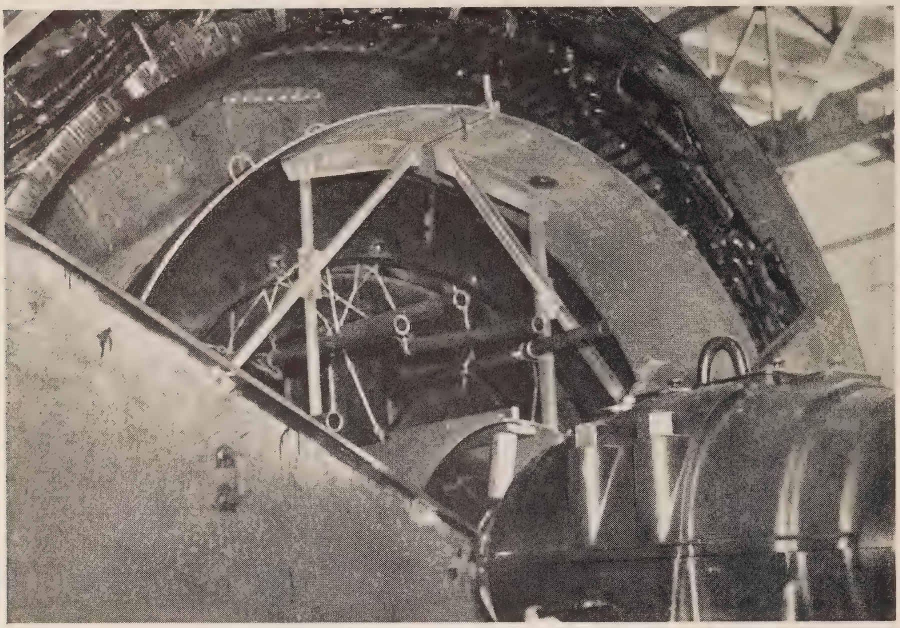


*Fig. 4—The bracing for the vacuum chamber.*

of the process, heat insulation for the vacuum chamber. A fan and a 125 to 250 kw. electric heater is used to blow warm air into, first, the vacuum chamber, and later into the surrounding wall board housing.

The warm air (118 deg. cent.) is blown into the vacuum chamber through a special handhole in the top sector. Advantage is taken of the reinforcing cylinders, which have already been described, to deflect the warm air through the air ducts of the rotor iron, then radially outward through the stator coils and finally through an opening at the bottom of the stator. This ensures uniform heating and will raise the temperature of the windings up to 90 deg. cent. in from 24 to 48 hours, depending on how wet they may be. Further, this heating is assisted by connecting the stator windings in series and applying to them a variable low voltage d.c. adjusted to supply approximately 50 kw. of heating energy. The exhaust air is returned to the fan, reheated and circulated again, thus making it necessary to supply only the heat absorbed by the generator and that lost.

When the temperature of windings reaches 90 deg. cent., the air supplied to the inside vacuum chamber is cut off and the handholes are sealed; the heated air is now circulated inside the wall board casing to maintain nearly the same temperature inside and outside the vacuum chamber, thus minimizing the loss of heat from the unit. This procedure is so effective that the 50 kw. circulated inside the stator winding from the low voltage d.c. supply gives full control of temperature

to meet all the requirements of the vacuum process.

The next step is to start gradually exhausting the air from the vacuum chamber, dropping the pressure in approximately $2\frac{1}{2}$ lb. steps (5 in. mercury). Great care has to be exercised in reducing the internal pressure and regulating the temperature to ensure that the temperature will not exceed by more than 10 deg. cent. the boiling point of water at the pressure inside the tank. If this precaution is not taken, there is a danger of developing sufficient steam pressure inside of the coil to burst its insulation. To facilitate the expulsion of water from the coils, thereby reducing the internal pressure, a small portion of the belt insulation on their hand-taped ends is opened up. The changes in pressure and temperature are regulated to condense approximately half gallon of water per hour, which is deemed to be a safe rate, under the circumstances.

When a vacuum of 26 in. (the maximum obtainable with the equipment) together with the proper internal temperature has been established, this condition is maintained until a negligible amount of water is being collected in the condenser; then the temperature is gradually increased to 90 deg. cent. while the vacuum is held constant at 26 in.

From one of the generators reconditioned in the manner just described, 12 gallons of water were removed from the stator winding. No previous attempt had been made to dry this generator. From another unit, which had been drying for weeks under the circulating heat method, and which the megger readings indicated as dry, over three gallons of water was removed.

The insulation resistance of the windings of generators dried under the vacuum process have reached values of from 42 to 82 megohms at approximately 85 deg. cent. Such insulation values coupled with the fact that at 90 deg. cent. and 26 in. vacuum, no further moisture collects in the condenser, would seem to constitute a reliable indication that the winding is dry.

The complete process of assembling the vacuum chamber, drying out a generator, and then dismantling the chamber to provide for a high potential test of the winding, requires approximately one week.

The most difficult parts of the generators to recondition were the field poles on which the insulation from ground between the winding and iron consisted of asbestos, fuller board, cambric cloth, fibre and certain hygroscopic substances. Because of the confined space into which this material had been packed and its poor condition mechanically, it was difficult to drive out the moisture from the water-soaked insulation. Moreover, a large number of the insulating collars were fibre, which warped and broke when dried out. Others were made of laminated wood and the water destroyed the glue; when dried out, these collars disintegrated into thin cracked pieces of wood.

A test of the voltage drop between the individual turns on the coils disclosed many short-circuited turns. On account of this, it has been or will be necessary to remove and repair the

field pole windings from some eleven rotors. When this course was found to be necessary, a study was made of the various materials available, so that one having high mechanical strength, qualities to withstand high temperature, and moisture-resisting characteristics might be obtained.

In reconditioning field poles, the procedure which was adopted is as follows: The poles are removed from the rotor, dried in the vacuum tank and the coils are tested for insulation between turns, after all the old ground insulation has been removed. Those found defective are repaired by inserting new paper or asbestos insulation as required.

After the field coils are re-insulated, they are impregnated under vacuum with Bakelite varnish. When removed from the vacuum tank, they are placed in large clamps, which are tightened to produce a pressure of over 1,000 lb. per sq. in. With the clamps still attached, the coils are placed in a baking oven for 24 hours at 120 deg. cent. and baked to a solid mass. They are then removed from the clamps, tested to ten times normal voltage between turns and, if passed, they are then provided with the ground insulation to insulate the copper turns from the iron core of the pole. This insulation consists of three layers of .015 in. Bakelized cloth cemented between layers and to the coil with Bakelite cement. Next, the coils are placed inside a special clamp to compress the insulation against the copper and they are returned to the oven, where they are baked for 24 hours at 120 deg. cent. At this time a thin coating of Bakelite cement is baked on the outside of the winding to seal the copper edges against dirt and moisture.

Under the process described, solid coils, sealed against dirt and moisture, and with ground insulation of high mechanical strength are produced. Ground insulation plays a very important part, as its failure can result in completely wrecking a machine, should more than one field pole become grounded simultaneously, producing a badly unbalanced heavy rotational member with high peripheral velocity. Because of this, and as the ground insulation of the field poles is subject to great centrifugal stress, mechanical strength and durability are as important as insulating properties. The type of insulation used in rehabilitating the field poles is strong mechanically and it has a puncture test of 27,000 volts. Nevertheless, all reconstructed field poles are tested to 3,000 volts before being placed in service where the normal operating voltage is 250 d.c.

As rapidly as the various pieces of equipment can be reconditioned and tested, they are being restored to normal service and, so far, no failures attributable to inadequate drying out have occurred. However, until the rehabilitated equipment has been in use for a few years, under regular operating conditions, sound conclusions cannot be reached as to whether or not the normal life of the insulation has been materially shortened by the flooding of the plant. In the meantime, it is gratifying to know that it has been possible to dry out and restore to service so much apparatus which had been submerged in water for several

hours, and that on some of this apparatus higher values of resistance have been obtained by means of the vacuum drying process than were ordinarily maintained in operation before the plant was flooded.

# Our Sun

THE sun is about the smallest and weakest of the stars, but to us it is the most important body in the heavens. We are dependent upon it for light, heat, growth and production, and also for the stability of the earth's motion in space—in holding it at the proper distance so that we may enjoy these benefits.

To the greatest part of the people of the east, the sun has been an object of worship for untold centuries. They called it "The King of Heaven"; to the Phoenicians and Israelites, it was "Baal"; to the Moabites, "Chemosh", and to the Amorites, "Moloch".

The ancient Hindus fancied that the sun was drawn across the sky by a number of fiery horses, red and golden in colour. The Romans believed it to be the wheel of Pheobus Apollo's chariot, and that each morning this Sun God arose from the eastern sea and drove his four spirited steeds across the sky, and in the evening descended into the western sea. At night, he returned to the east by a golden boat which was borne along the northern edge of the earth.

With the acceptance of the Copernican theory about the end of the sixteenth century, however, the sun was recognized as the centre of our solar system, with all of the planets revolving around it. This central body then became even more important when it was realized that it was also the centre of that force which keeps these planets stable in their motion.

The sun has a diameter of about 110 times that of the earth, or 865,000 miles, and it appears slightly more than one-half degree wide, being approximately 92,000,000 miles distant. It is observed to rotate on its axis, in the same direction in which the planets revolve around it, but its periods of rotation differ according to the latitude on the solar surface—i.e., at its equator, the period is approximately 25.3 days, whereas at both poles it is much longer, 35.4 days—which phenomenon proves that the sun, as we can see it, is not a solid body, but gaseous. The surface temperature is about 5,700 degrees Centigrade, or 10,000 degrees Fahrenheit.

The sun consists, firstly, of the "photosphere" — the light-giving sphere, which has a mottled appearance due, it would seem, to ascending and descending currents of gases of differing temperatures. On this surface, dark spots and white markings, "faculae", may be seen.

Over the photosphere is a thin colour layer, the "chromosphere", which appears as a narrow ring of rosy light visible at the time of a total eclipse.


*Fig. 1—Solar prominences, like flames rising from the surface and also clouds floating in the upper atmosphere.—Yerkes Observatory.*

### PROMINENCES

Above the chromosphere are clouds of luminous gases, known as "prominences", Fig. 1. These may be "quiescent", like clouds floating high in the atmosphere, or "eruptive", appearing as flames rising to great heights and changing rapidly.

### SUNSPOTS

It was Galileo, who, in 1610, discovered that the sun had dark spots on its surface, the photosphere, Fig. 2. These are, in reality, light-giving areas, but somewhat cooler and not so bright as the other surface, and they seem to be vortices, regions of downward suction. Each spot has a dark centre, the "umbra", surrounded by a less dark border, the "penumbra", Fig. 3. The life of these spots may be from a few hours to several months.

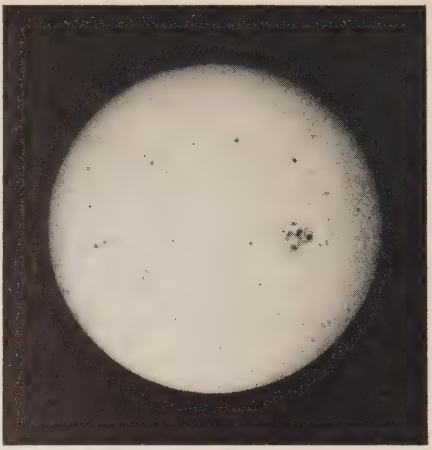


*Fig. 2—The disc of the sun, showing many sunspots. The dark central parts are known as the "umbra", the shaded areas surrounding these, forming borders, are called the "penumbra". Various white markings, "faculae", may also be seen.—Yerkes Observatory.*

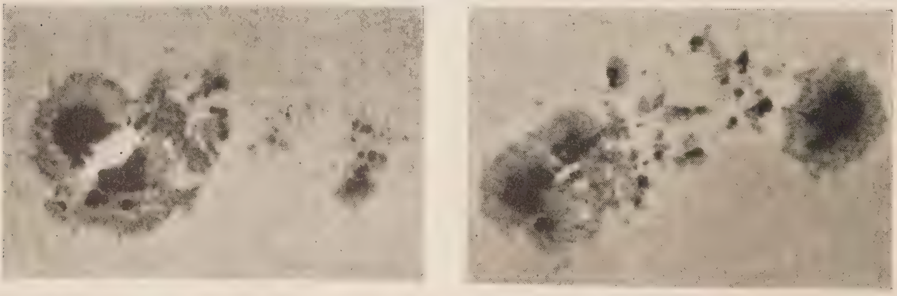


*Fig. 3—Photographs of the great sunspots of July, 1905, and February, 1917, showing umbra and penumbra, and also the mottled surface of part of the sun, the photosphere.—Yerkes and Mt. Wilson Observatories.*

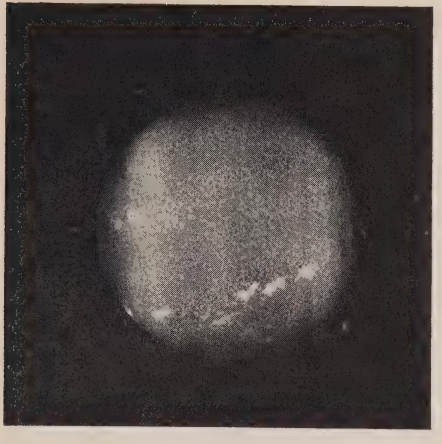


*Fig. 4—Calcium flocculi; the white areas are regions where calcium is prominent in the solar atmosphere. —Yerkes Observatory.*

It is observed that the quantity of sunspots varies, reaching a maximum about every eleven years, with minimum about half way between the maxima. Certain phenomena on the earth—weather, the aurora borealis, radio wave propagation and land line communication — vary through approximately the same period and, therefore, have come to be associated with the occurrence of sunspots, conditions being noticeably bad or good according as the spots are, respectively, maximum or minimum.

Sunspots have been found to possess the properties of a magnet, unipolar and bipolar, which may account for the disturbances observed in the aurora and in communication systems during what are known as "magnetic storms". These occur when there are large spots on the sun, the electron streams from which could strike the earth.

It is by observing the movements of the spots that the sun's rotation is determined.

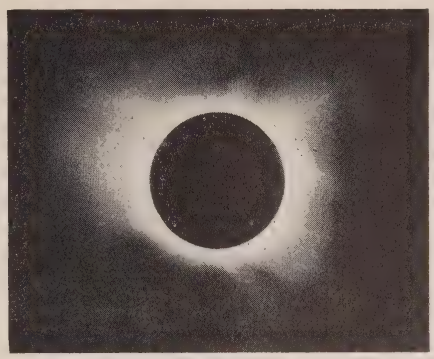


*Fig. 5—The sun's corona as it appeared at the time of the total solar eclipse of January 24, 1925.—Mt. Wilson Observatory.*

### FLOCCULI

About forty of the chemical elements are known to exist in the atmosphere of the sun, the most prominent being iron, carbon, calcium and sodium. By means of a special instrument, the spectroheliograph, photographs are made showing the areas in the upper atmosphere where certain elements are most dense. These areas are known as "flocculi", and the illustration, Fig. 4, shows bright regions where calcium is present.

The element "Helium" was first discovered in the sun's atmosphere and later found to exist in the earth and its atmosphere.

### CORONA

During totality in a solar eclipse, pearly white streamers are seen reaching out from the sun to distances varying from one to ten diameters; they form what is known as the "corona", or crown, Fig. 5. The nature of this corona is still a matter of speculation, but its density evi-

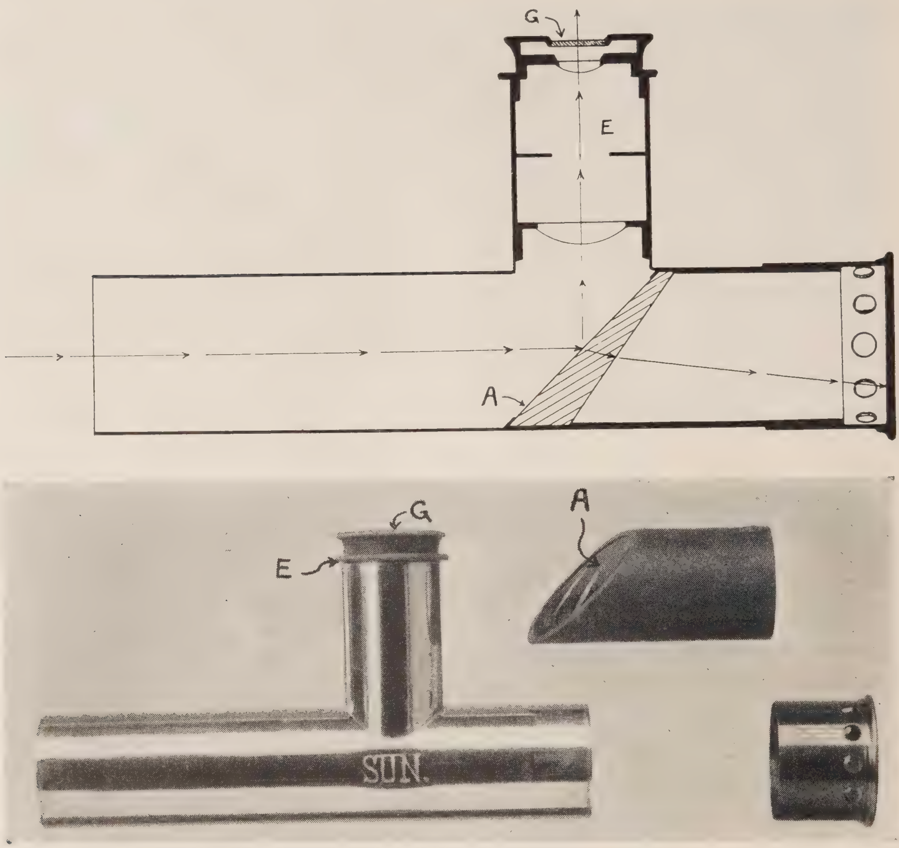



*Fig. 6—The Herschel solar eyepiece,—a very suitable means of reducing the intensity of light so that the sun may be observed without injury to the eye. The special prism, A, is commonly called the "Herschel Wedge". E is the ordinary eyepiece; G, the dark shade glass.*

dently is very low, for comets passing through it are not disturbed. Presumably, it consists of electrons driven off by the sun and pushed away by the pressure of its light rays in much the same manner as comets' tails are formed.

The corona is observed to change its shape according to the quantity of sunspots existing, the longest streamers occurring when spots are minimum.

### Observing the Sun

There is a very great risk of permanent injury to the eye if one attempts to observe the sun through a telescope which is not properly equipped with a device to reduce the amount of light for, as with any magnifying glass, there is intense heat at the point where the sun is focussed by the objective (front) lens, or concave mirror, in a telescope.

For very small instruments, it may be sufficient to cut down the effective

area of the objective lens by means of stops—smaller openings—and then to use a dark shade glass over the eyepiece.

With larger telescopes, having objective lens, or mirror, of diameter more than 3 inches, the above method of stopping down the lens may not be satisfactory, particularly for higher magnifications, as the diffraction of light would reduce the sharpness of the image. Either of two other methods may then be used.

The Herschel solar eyepiece, Fig. 6, invented by Sir John Herschel, is a right-angle reflector consisting essentially of a clear glass prism which bypasses about 95 per cent. of the sunlight, and reflects only the small remainder from its front plane surface to the ordinary eyepiece. It is in the form of a prism, rather than having parallel faces, in order that reflections from the rear surface will not interfere with those from the front.

A dark shade glass must be used over the eyepiece as before.

The third method, used in still larger instruments, effects the result by the partial neutralization of polarized light. The rays when nearing their focus are reflected, by the plane faces of a pair of parallel black mirrors, to another similar pair of mirrors which are caused to rotate for adjustment. The rays emerging from the first pair of mirrors are "polarized", vibrating in one direction only: the second pair of mirrors, according to their position, opposes to greater or lesser degree, the reflection of the polarized rays, and can even completely block them off. This system, therefore, may be adjusted to pass only the desired proportion or amount of light for the observer.

No shade glass is necessary with the polarizing eyepiece, and this is of some advantage in that the rays of all colours are passed through in their proper proportion—there is no tinting of the image as is usual with coloured shade glasses.

With any of the above attachments, the dark spots and white markings may be seen, and the rotation of the sun becomes apparent.

To observe solar prominences, however, a "prominence spectroscope" is necessary. With this instrument, an opaque disc is placed in front of the image of the photosphere, the prominences may then become visible around the edge of this disc.

The corona may be seen during the totality period of a solar eclipse without the aid of any instrument. Up to the present, however, there is no known means whereby it can be seen at any other time.

By using a spectroscope, the spectrum of the sun may be observed or photographed. This gives the band of rainbow colours, the components of our standard light, from which the elements in the sun's photosphere and atmosphere are determined.

The sun, to us, is by far the brightest star. There are others much larger. Some have visible companions and the pair rotate about each other in long periods of time. Some stars are seen to flare up and then reduce to a lower steady brilliancy, while many others, as our sun, do not exhibit any noticeable change — self-luminous celestial bodies which are at extremely high temperatures, but, seemingly, neither cooling down nor burning and being consumed.—*F.K.D.*

# Life, Death and Short-Wave Radiation

By S. G. Hibben, Lamp Division, Westinghouse Electric & Manufacturing Co.

*History is likely to record that the development of a simple, practical means of destroying bacteria was one of the most important contributions of electrical engineering science to man. This germicidal lamp is cleverly devised to produce peak output in the sub-visible spectrum. Sterilization of air, food and articles important to man's health becomes fully practical at very little cost and inconvenience. —Editor, The Electric Journal.*

THE invisible short-wave radiations in the electro-magnetic or ether spectrum have long been known to possess various peculiar biological and chemical properties. These radiations are contained roughly in the region bounded on the long-wave side by the violet of the visible (rainbow) spectrum and on the short-wave side by the limit of transmission through air, or, more particularly, by the transmission limits of fused quartz. The wave-length boundaries of this region can be generally considered as from 4,000 to approximately 1,800 Angstroms. (Angstrom = 0.1 millimicron = 0.0000001 millimeter, or there are 250,000,000 Angstroms to the inch.)

By common agreement, the energy emitted in this region has been designated as ultraviolet radiation and until recent months there was little or insufficient data to define clearly the differing properties of some rather definite portions of this region. It was known that certain materials, especially inorganic compounds, would absorb portions of the ultraviolets, such as the strong 2,537 and 3,650 Angstrom bands of mercury-vapour emission and re-radiate some of this emission at longer wave lengths (5,000 to 6,000 Angstroms) to Angstroms within the range of the human seeing organs, that is, would exhibit fluorescence or phosphorescence. Other portions of this region, especially the radiations centering at about 2,960 Angstroms and, to a lesser degree, at 2,500 Angstroms will induce reddening of the skin and by prolonged exposure, a pigmentation. Erythema or tan thus indicated an absorption of these wave lengths by the human skin, which, when coupled with certain chemical changes linked with vitamin production or calcium metabolism in the body, led to the designation of these wave lengths as biologically effective.

Somewhat shorter wave lengths were known to kill bacteria and micro-organisms, such that in the region roughly centering at about 2,600 Angstroms, there were found to exist definite abiotic or "death-ray" properties. Still shorter wave lengths chiefly below 2,000 Angstroms were most influential in producing ozone

*Sterilamps used as part of the modern hospital operating room fixture.*

and nitrous oxide, but have been considered of little commercial usefulness, especially since no practical container has been devised that would transmit this radiation below the limits of fused quartz.

Recent studies made by research engineers have suggested a division of this whole ultraviolet region into four portions as follows:

Fluorescent or near ultraviolet, 4,000 to 3,200 Angstroms.

Biologically effective or erythemal region, 3,200 to 2,800 Angstroms.

Abiotic or sterilizing region, 2,800 to 2,000 Angstroms.

Ozone-producing region, 2,000 to limits of air transmission.

One must recognize that these limits are not sharply defined, and

merge or often overlap. The latter two portions, or radiation shorter than about 2,900, must be man-made —such radiations do not reach the earth's surface from the sun.

The third portion or the abiotic region is one which challenges our immediate attention, since the radiations of these wave lengths, when properly applied, most assuredly can aid in the prolongation of human life and in the betterment of living conditions through their lethal effects on micro-organisms and fungi.

### Mechanism and Characteristics of the Sterilamp

The reactions of most of the well-known bacteria to radiation have been recently studied by Doctors Rentschler, James, and associates, of the Westinghouse Lamp Division. This work has led to the development of a carefully planned type of vapour source known as the Sterilamp, emitting a controlled bactericidal radiation. It consists essentially of a glass tube containing mercury vapour and, in the ends, electrodes with electron emission coatings. Small portions of other gases are added to the mercury, thus improving operating conditions and permitting the arc discharge to become established through the 20-inch length tube at something on the order of 575 volts.

After satisfying these requirements, a sterilizing lamp must consume a minimum amount of power or radiate a minimum of heat energy, since its logical places of usage are often in enclosed spaces, such as display cases and refrigerators, or near food products, where high temperatures are to be avoided. Consequently the evolution of the Sterilamp led to commercial tubes that normally consume 0.03 to 0.05 ampere, an average of 35 milliamperes. A 20-inch tube operating at some 375 volts may thus consume approximately 12 watts, which is only sufficient barely to warm it to the touch.

Short-wave radiation possessing bactericidal properties is not to be confused with the emission from "health lamps". Sterilamps should not be viewed by unprotected eyes at close range or for long periods, lest eye-sunburn or conjunctivitis result. Ordinary erythema is very slight or negligible.

A further requirement involved the development of a quite special glass, free from iron and other impurities and capable of transmitting the short-wave radiations down to approximately 2,000 Angstroms when employed in the carefully graded wall thickness of Sterilamp tubing. Furthermore, the transmission of such glass (not used in sun lamps or similar health lamps) has been purposely chosen to be negligible for wave lengths encountered in the emission from low-pressure mercury vapour, such as normally found at the bands of 1,850 Angstroms or shorter. Such wave-lengths being in the ozone-producing region are considered quite deleterious in connection with any normal applications of the Sterilamp and are purposely removed by glass absorption, as a protection against irritation of the nasal membrane and unwanted changes in some fats and foods.

A third important requirement of the Sterilamp has been the concentration of its output largely at the 2,537-


*Contamination on cafeteria glasses before and after irradiation. Numbers 1, 3 and 5 are drinking glasses normally contaminated. Numbers 2, 4 and 6 are sterile glasses having been irradiated and showing a complete absence of germ colonies.*

Angstroms' region of the spectrum, because generally at this wave length we find the greatest sterilizing or bactericidal power. In fact, something in excess of 80 per cent. of the radiant energy output of the Sterilamp occurs at the point of maximum destructive power to minute organisms.

Hence this device might properly be termed a highly efficient one in this particular service. With its useful life on the order of 4,500 hours (six

months of continuous usage), the renewal costs seem low. Since these lamps may be operable for considerable periods after their effectiveness is depreciated, it becomes necessary to follow a group or periodic replacement schedule of six months.

The low vapour pressure and low current density in the tube reduce to a minimum the energy emitted in the visible spectrum. This is a pleasant light-blue colour, but negligible for any illumination purposes, since at 15 inches from a tube the illumination is about one foot-candle. As with any carefully designed low-pressure lamp, the occurrence of low external temperatures will reduce output, hence the Sterilamp is not recommended at temperatures below some 40 deg. fahr.

The Sterilamp coupled with the Rentschler ultra-violet meter, which has evolved simultaneously, permits of direct quantitative measurements and the building up of values of abiotic energy necessary to kill any chosen micro-organism. For example, the tantalum photo-cell having much the same wave-length response to ultra-violet radiation as the lethal action of these radiations upon bacteria, permits evaluating quantitative ratios or relative energies to kill organisms.

The time required to kill micro-organisms is greatly influenced by circumstances, but an indication may be had from noting that one 30-inch Sterilamp usually affects 100 per cent sterilization in less than one minute at one foot, or four minutes at three feet. The time in any particular case, of course, depends on the type of bacteria, as the resistance varies.

In the destruction of typical organisms it is interesting to note that when the radiated energy has wave lengths much longer than 3,000 Angstroms, the lethal effect is generally negligible. In a typical case it requires approximately six times the energy at 3,000 Angstroms to be as lethally effective as the radiation at 2,600 Angstroms. Consequently the proper design of a device, such as a Sterilamp, becomes one of exactitude and the commercial article represents the result of many thousands of experiments both as to materials of construction and electrical characteristics. More important has been the actual work on germ cultures and bacteria in many forms and locations. Studies of the larger organisms, such as paramecia, have thrown much light on the rapid rate of destruction, and on the peculiar disintegrations of cells that follow.

### Applications

Among the most important of the rapidly developing applications is the destruction of disease germs or air-borne bacteria exhaled in breathing or from the mouth or found present in air, usually riding about on minute particles of dust. To eliminate these organisms it is considered practical to employ batteries of Sterilamps in air ducts or in the condensing chambers of dust-removal devices like the precipitron especially if the air, as in clerical offices, schools, or closely inhabited spaces, is recirculated or agitated.

In hospitals, particularly in the operating rooms, the risk of contamination of any wound from air bacteria is always present and the elim-

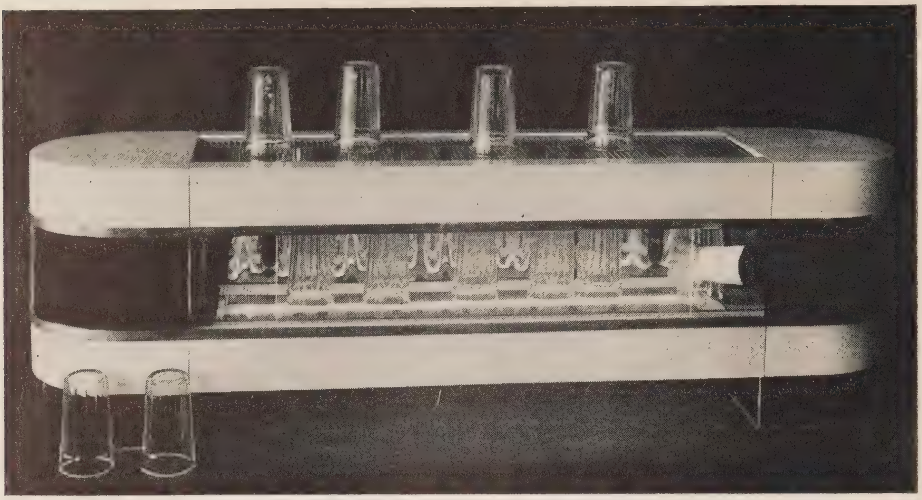
ination of this hazard becomes the last and most intriguing step in the perfection of aseptic surgery. Remarkable records in numerous hospitals, where batteries of Sterilamps have vastly reduced the bacteria count in the region of the operating table, have indicated the fact that over distances on the order of five to ten feet the bactericidal power was sufficient to insure quick healing of tissue, reduction of fever temperatures—in fact, creating a vital insurance for human life itself.

In the preparation and packing of meat, foods and allied products one finds it important to sterilize the containers or wrappers; the surfaces of material packed in jars and many items subject to the eventual contamination by fungi or molds. In this classification one of the most interesting is the destruction of mold spores in air in bakeries to reduce the mold growths on the bread and on almost any baked goods. Preventing the contamination by radiation seems much more important and much more practical than eventual destruction of spore or fungus after it becomes rooted and growing. In bakeries, one 30-inch tube for 50 to 100 square feet of floor area seems sufficient.

Another basic application is the placement of Sterilamps in commercial refrigerators, particularly where meats are stored. Usually one 30-inch tube is recommended for each 30 to 50 square feet of floor area. Here the important operation is to destroy airborne fungi in addition to any direct surface radiation of the meat and hence a continuous agitation of the air as by a small electric fan is an important part of the operation. Also it develops that a lesser degree of refrigeration, or some 10 deg. fahr. higher temperatures can be permitted without deterioration of the meat. In an ordinary ice-cooled box, there may be excessive accumlation of mold and slime, but in sterile air this is eliminated and temperatures as high as 40 to 45 deg. fahr. appear safe. Higher temperatures permit higher humidities, which result in a 5 to 10 per cent reduction in the drying or weight shrinkage of meat. To this saving must be added the reduction of trimming made necessary by surface deterioration that follows the growth of mold on aging meats. In refrigerated display cases in retail stores the maintenance of a sterile atmosphere and a lessening of the rigorous requirements of low-temperature refrigeration become items of profit to the merchant and health insurance to the consumer. Roughly, one 30-inch tube for each four and one-half feet of case will meet requirements.

In the majority of public eating and drinking places it is generally important to sterilize drinking glasses, flat silver, dishes, numerous food containers that come in contact with the mouth and that are potential breeders and distributors, especially of pathogenic oral bacteria. Prevention of disease and reductions of epidemics seem now much more practical, using the Sterilamps to purify by two or three minutes of irradiation where high-temperature steam baths or concentrated and often unhealthy chemicals constitute impractical or less desirable methods.

Many other uses are rapidly evolving, such as reductions of contamination of milk in dairy barns; the con-



*Method of using Sterilamps to sterilize counter-type drinking glasses.*

trol of bacteria on all commonly handled articles of apparel; reductions of fermentation or mold losses in food preparations or storage—all these and many more spelling out a death sentence for unwanted disease germs and representing an eventual insurance for longer and happier human lives.

Taming the death ray is one of the most important results of scientific research that has occurred in this generation. Potentialities are so great that the Sterilamp and its carefully restricted output of ultra-violet radiation has awakened an excited interest as the newest and sharpest tool available to the electrical fraternity and to all interested in hygiene and health, in the up-building of longer and happier lives and the reduction of decay, spoilage, and similar economic losses.—*The Electric Journal.*

# Concrete: Its Maintenance and Repair

By R. B. Young, Testing Engineer, Hydro-Electric Power Commission of Ontario

*(Continued from May)*

### TYPICAL JOBS

The methods outlined in this paper for the repair and maintenance of concrete have been used successfully on many jobs by the Hydro Electric Power Commission of Ontario and others, and before concluding, it may be of interest to describe briefly a few that are typical.

The first case is that of a large storage dam of the Ambursen type, approximately 1200 ft. long and 50 ft. high at its deepest point. Eighty-five buttresses of varying height, spaced on 15-ft. centers, carry a reinforced concrete slab ranging in thickness from 11 in. at the top to 28 in. at the bottom of the deepest section. (Fig. 2).

The dam was built in 1914, of screened and washed sand and gravel of fair quality, proportioned 1:2:4 for the slabs and 1:3:6 for the buttresses. The workmanship and the quality of the concrete were good for structures built at that time.

Trouble with this structure was observed within ten years after completion and in 1927, an investigation was commenced to determine the cause. The concrete was watched closely for two years, by which time it was apparent that the deterioration was due principally to movements of water through cracks and porous sections, from front to back of the slabs and buttresses. The design of the reinforcement in the haunches of the latter contributed to this condition for no provision was made for tensile stresses in the direction of the supported slab. (Fig. 3). When the slabs did not slide freely on the haunches, as was intended, such stresses developed, and cracked a large number of the latter roughly parallel to the axis of the buttress piers. (Fig. 4). This, in turn, permitted access of water to the concrete, which by pressure and capillary action, found its way to the surfaces. In passing through, the water rotted

*Fig. 2—General view (shortly after completion) of dam which was repaired.*

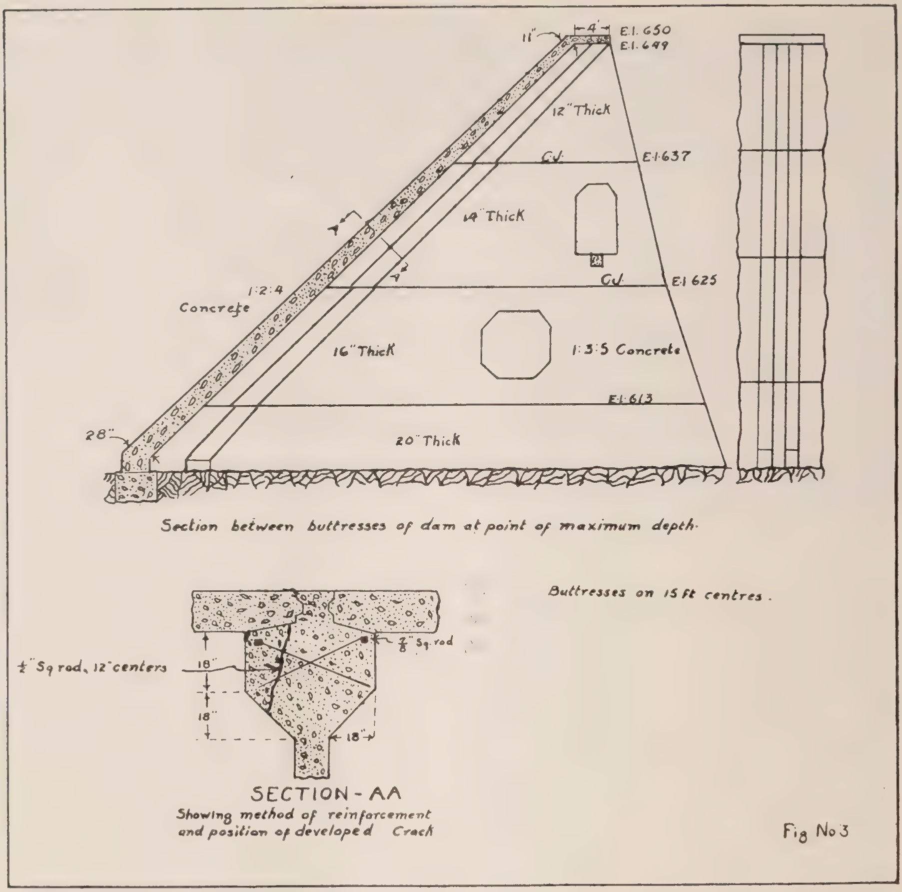



*Fig. 3*

the concrete with the result that soft spots of considerable volume developed in 17 of the piers. On exploring these by drilling, it was found that the condition of the concrete became steadily worse, the closer one came to the front of the dam and it was evident that these spots were but the surface indication of a cancerous condition in those parts of the structure which were deteriorating.

Similar spots were found in a number of the slabs, principally in those parts in which the concrete had segregated during placing, but with a few exceptions, they were of small size. The disturbing feature about the deterioration of these slabs, was that the trouble was steadily progressive and gave evidence of spreading beyond the segregated areas into sound concrete. There was also a tendency for the movements of water, which were the direct cause of the decay, to develop wherever a structural crack occurred in a slab, even in sound concrete, although in these locations, the deterioration was at a very much slower rate.

The water impounded by this dam

*Fig. 4—Crack in haunch of buttress caused by dragging of slab which it supports.*

was soft, but was not acid and ordinarily would not be considered corrosive to concrete. However, it has been the author's experience, that any water, even if hard, will, in time, rot concrete if that concrete is sufficiently porous to permit its movement from place to place.

When it became evident that repairs would soon be necessary, possible methods of restoring this dam were studied. Consideration was given to the construction of a new slab, to waterproofing the existing slab by various means, to converting the old dam to an earth dam and other schemes; but any of these would have been very costly and would have necessitated the shut-down of an important generating plant for a period of months, and the loss of valuable water. It was finally decided that the most satisfactory solution was to build a new dam of the same general type within the old, for this could be done piecemeal, only replacing as needed, those sections that had become weakened. The advantages of this scheme were that it did not necessitate the unwatering of the dam or the building of an expensive cofferdam, and only those piers or slabs that required strengthening need be done at any one time. It had the further advantage that it was not necessary to remove the decayed concrete from the old structure or even to waterproof it, as no dependence was being placed on the old dam for carrying the load.

Economically, this plan was attractive, for it spread the cost of the reconstruction over a long period. In fact, the money that had been set aside for renewals were more than sufficient to make the initial repairs and the present rate of deterioration is such that the costs of future reconstruction will be kept well within the limits of this amount so that at the end of the estimated life of the original struc-

*Fig. 5—Method of repairing buttress and haunch of dam.*

Note at left haunch trimmed back partly to allow for recess to hold slab; and at right, the system of reinforcing used. Dowels are carried through and into a similar section, added to the other side of buttress.

ture, the then existing dam will be practically as good as new.

In the summer of 1929, one of the slabs developed a crack that was plainly due to a structural failure and immediate steps had to be taken to repair it. In as much as it was necessary to bring in considerable construction equipment for this work, it was decided at the same time to repair all of those buttresses that were badly decayed.

The general plan followed in repairing the dam was to provide new piers alongside the old, capable of carrying the full load of the structure. These were tied to the existing piers in such a way that the load would be transferred to them and they were provided with recesses at the front end into which a slab could be built when it became necessary to strengthen the old. Details of the methods are shown in the illustrations. (Fig. 5 and 6).

Screened sand and gravel similar in quality to that of the original construction were used in the repair work but so proportioned as to give a concrete having a 28-day compressive strength in excess of 3,000 p.s.i. The concrete was cured by leaving the side forms in place for several days after casting and by keeping the surfaces wet. All joints with the old concrete into which water might penetrate, were primed with an asphalt solution and sealed with an emulsified asphalt putty.

This repair work has now been in service for seven years and in this

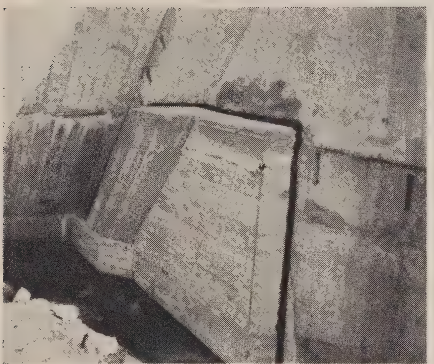
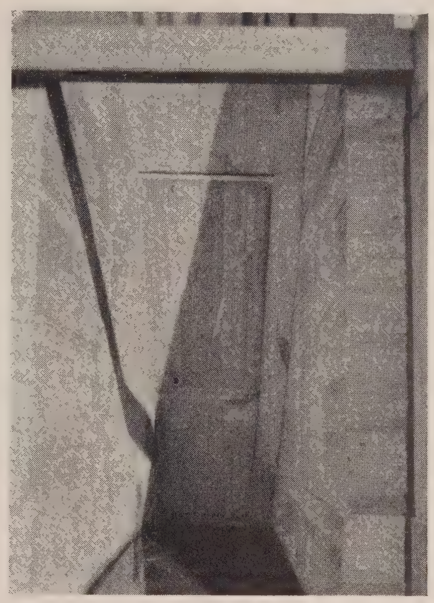



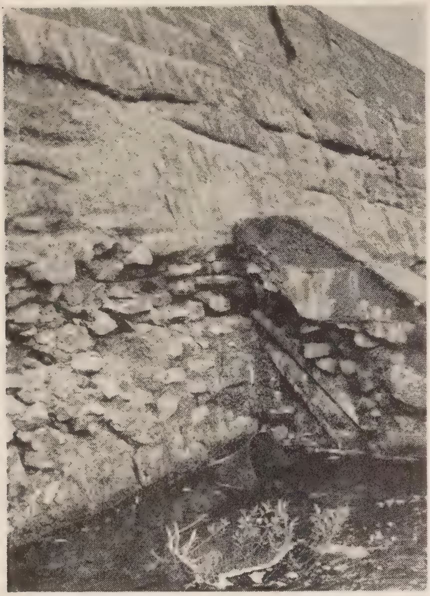
*Fig. 6—Completed repairs to haunches of dam.*

Note at left, use of asphalt putty to seal joint; and at right, replacement of a defective part of a slab.

time has proven satisfactory in every way. It is anticipated that further repairs to this dam will be required within the next two years and the same methods will be used but the amount of work to be done will be very much less than in 1929, for the rate of deterioration is slowing down, as more resistant concrete is reached. It is probable that before the dam has to be entirely rebuilt, the rate of deterioration on the original structure remaining, will have become so slow as to be negligible and that then further repairs will be unnecessary.

An interesting repair, which illustrates the use on one job of a number of methods, was the case of a small hydro-electric plant in Eastern Canada. Concrete has been used in this plant to build the canal and forebay walls, and for the powerhouse and superstructure foundations. The gravity wall forming one side of the forebay had been built of such a scant section that it was unstable. Part of this wall fell over shortly after the plant was first put into operation and the previous owners had thickened the deeper sections by adding concrete to the front and by the addition of a few small buttresses at the back.

About everything that could be wrong with a structure was wrong at this plant. The concrete was made from local pit-run gravel, and was probably dirty as used, for information obtained locally indicated that the pit from which it came had not been even stripped. No information could be obtained as to the proportions used but the appearance of the concrete indicated very lean mixes. A great many plumbs were added in the forms and these were allowed to lie close to the surface and to each other.



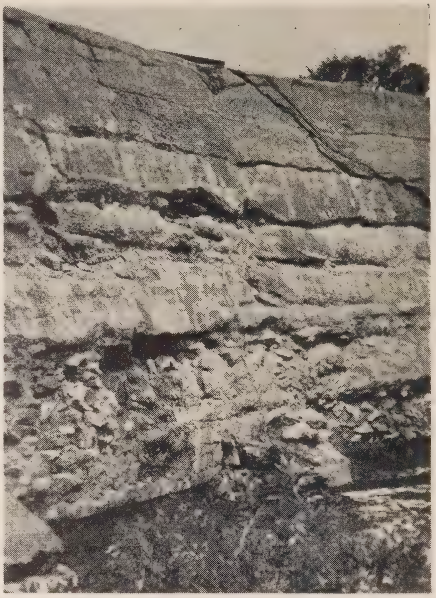


*Fig. 7—Typical sections of defective gravity wall prior to repair.*

The placing of the concrete was of the crudest, and the walls were everywhere a succession of fill planes, yet in spite of this, little segregation existed. The resulting concrete was porous and readily attacked by frost wherever seepage took place but except for its extreme porosity, it was remarkably hard.

Last spring, a section of the canal wall was shifted by ice pressure and it became necessary either to rehabilitate or abandon the plant. The former was decided upon and a study made of what should be done. Besides replacing the shifted canal wall, it was evident that the gravity walls had to be strengthened and made watertight, the wheelpits had to be waterproofed, and finally, it was advisable to protect the old walls from weathering.

Various schemes were considered and the method adopted was to build an 18-in. curtain wall of concrete which would blanket the entire upstream face of the gravity wall and thus effectively cut off any flow of water through it; this curtain wall would also help to strengthen the wall. A new toe was cast on the downstream side, extending from rock upward to a point where it would cover the worst of the disintegration. This was tied into the old concrete so that the two would act as a unit. A cap was built on top of the old wall and

*Fig. 8—Inside faces of walls before repairs.*

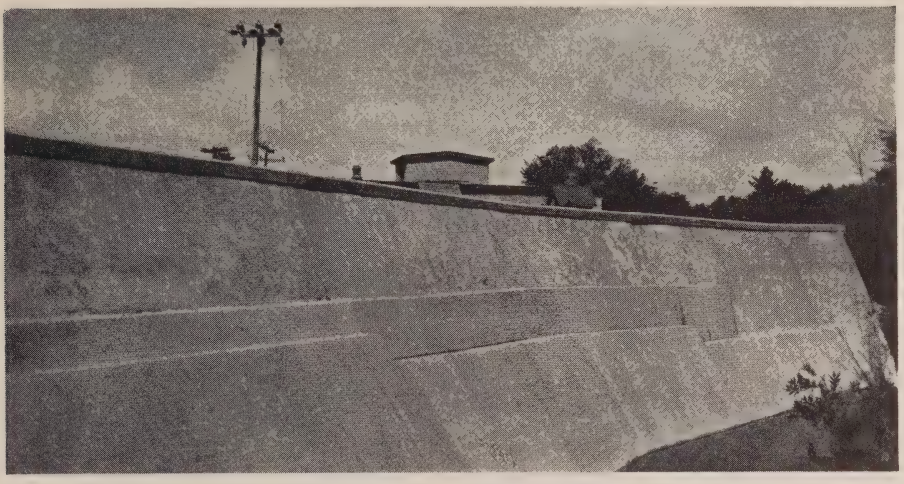


*Fig. 9—Completed repairs to gravity wall. Top section is pneumatically applied mortar; bottom is concrete cast in place.*

the new section at the front. The few feet of the old wall still exposed on the downstream side was then surfaced with two inches of gunite, reinforced with wire fabric, fastened to the old concrete with dowels. Details of the work and also the condition of the concrete prior to the reconstruction are shown. (Fig. 7 to 10).

The concrete used in the repair work was made from local sand and gravel, screened and of good quality, proportioned to give a dense and watertight concrete; its average 28-day strength was 3,300 p.s.i. The concrete was pumped to the forms and was there consolidated by vibration. Vertical joints were treated with emulsified asphalt and horizontal joints were eliminated by casting all sections, rock to top, in one operation.

A third job, completed several years ago, illustrates the effect of rate of deterioration on the need for repair. The structure in question is a large building that has been added to from time to time. The first section was built about 1905 and the last in 1918. The building is exposed continually to spray and in cold weather to a great many cycles of freezing. In the course of time, parts of the building became deteriorated, but it was observed that the 1905 construction was in as good or better condition than that built thirteen years later.

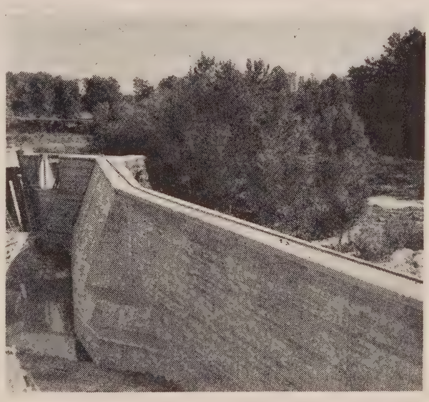


*Fig. 10—View of front of gravity wall after completion of 18 in. concrete blanket wall and cap.*

*Fig. 11—Face of section of building 25 years old. Note—While concrete looks rough, actual deterioration is small.*

*Fig. 12—Cornice of section 12 years old. Note advanced deterioration on top step and patch below, already coming away.*

*Fig. 13—Method of building up cornice to take copper. No attempt made here to remove all affected concrete, only that which was soft or loose.*

*Fig. 14—Completed repairs of cornice of 12-year old section of building.*

Considering the time the former had been in service, it was felt that the rate of deterioration was so slow that no repairs to this part of the structure were required. On the other hand, the poor condition of the 1918 concrete, indicated that early repairs of this section were inevitable, and it was decided to make these before the deterioration had proceeded so far that a great deal of rebuilding would be necessary. (Fig. 11 and 12).

The method of repair was very simple and effective. The trouble was mainly confined to the cornices and these were scaled of all loose concrete, built up to line and grade and covered with copper. The use of copper was decided upon because of the poor quality of the original concrete and the fact that the quantity that otherwise would have had to be removed entirely to eliminate decay, was so great that the copper covering was very little more expensive than complete restoration and, from the standpoint of permanence, offered a more certain repair. (Fig. 13 and 14).

Somewhat similarly, very successful repairs have been made to the upstream faces of piers which were unravelling at the water-line, by covering them with steel plates. These plates were anchored to the old concrete by bolts and by bending the back edges into chases cut in the sides of the piers. The space between the plate and the pier was filled with grout.

Some of these plates were removed after being in service a number of years and no disintegration of the concrete behind them was found. This may seem strange, but might be expected when it is remembered that the steel extends into water and the cycles of freezing and thawing which the concrete behind the plate would receive annually, would be reduced thereby to a very small number compared to similar concrete unprotected. This method offers a very satisfactory means of repairing the fronts of piers without the necessity of taking the strutcure out of service. (Fig. 15).

*Fig. 15—Use of steel plates to protect porous concrete in nose of sluice pier.*

In repair and maintenance, the policy should be that of the Mikado of Gilbert and Sullivan fame, which was "To make the punishment fit the crime." There is no one method that is best for all conditions and any engineer charged with the responsibility of restoring a concrete structure, should approach the problem with an unbiased mind. He should first determine the causes of the difficulty, devise means for their elimination and then put the structure back into satisfactory operating condition, using whatever methods offer the required results with a certainty of permanence, with an appearance in keeping with the prominence and purpose of the structure, and with due regard to economy.

# Modern Prophecies

*When we compare the present uses of electricity with those visualized by Steinmetz before many of those uses had been developed, or even experimented on, it is surprising how many of his ideas have become present realities. One exception is the use of electricity for house heating. In a northern climate such as ours, with its seasonal variations of temperature, developments in electrical house heating are still far from anything that would prove economical.—Editor.*

THAT the development and widespread use of electricity would change the living conditions of people was foreseen by the engineer Charles Proteus Steinmetz in one of his writings of over twenty years ago. In the *Ladies' Home Journal*, September 15th, 1915, under the title, "You Will Think This a Dream", he gave some of his impressions of what the future then had in store. The following has been extracted from the article referred to:

The time is coming when the cost of electricity will be infinitely lower than now, and when that time comes it will revolutionize all our domestic life.

. . . when electricity becomes universally used, it will be against the law to have a fire of any kind within the city limits. The Government will not allow fires because they are dangerous, dirty, and insanitary; . . .

When we use nothing but electrical power for heating as well as for other purposes, the supply will come through transmission lines and big central stations of many million horsepower. These stations will be located wherever power is available, such as at waterfalls, coal mines, and oil and gas wells. . . .

When heating is done electrically, if I want seventy degrees in my home, I shall set the thermostat at seventy and the temperature will not rise above that point. This temperature will be maintained uniformly without regard to the temperature outside.

If it is very cold, electric heaters will hold the temperature at seventy. If it should be ninety or one hundred degrees outside, the same electrical apparatus will cool the air inside. . . .

. . . With electric equipment we shall be able to . . . have the humidity normal at all times. This electric equipment will have an absolutely automatic control of both temperature and humidity.

. . . When electricity is developed we shall have apparatus that will destroy bad air, bring fresh air into the home, and, when the air outside is not sufficiently invigorating, automatically arrange a distribution of ozone. . . .

. . . All cooking will be done by electricity. A great deal of our food will be cooked on the table. . . . Cooking by electricity will be very much more satisfactory and under perfect control. By adjusting the regulator, the food will be perfectly cooked automatically.

The telephone will be improved. If we want to hear a concert, we shall not have to go out in the crowd and sit in unventilated rooms. By means of the improved loud-speaking phones,

we may listen to the concert in our homes. . . .

With wireless telephones, if a singer should be singing in an opera in some European capital, we shall be able to listen to this opera in our own libraries in America. The new telephones will make it possible for millions of persons in moderate circumstances to hear the finest concerts in the world without crossing their thresholds.

With the motion picture and the talking machine perfectly synchronized, as they will be, it will not be necessary to go to the theatre for our amusement. These machines will be made for use in the home. . . .

. . . When fires are not allowed within city limits, electric automobiles, bicycles and tricycles will be developed, and, on account of the low price, will be available to almost everyone.

. . . With electrical energy available and with the application of scientific methods and the production of quantities of nitrogen fertilizer from the air—the cost of raising food supplies will be materially decreased. . . .

The use of electricity will so facilitate labour that the hours of labour will be shorter. The working day will not be more than six hours. . . .

Electrical power will be used so generally that it is very likely the cost will be on the basis of a tax, like our water tax. For example: so much a plug, as we are now charged so much a faucet. It will be very cheap and it will not pay to install meters and have them read. . . .

# THE BULLETIN

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# Load Building

By J. Albert Smith, M.L.A., Commissioner, Hydro-Electric Power Commission of Ontario

*(Address to the Ontario Municipal Electric Association and Association of Municipal Electrical Utilities at Bigwin Inn, Muskoka, July 5, 1938.)*

IT gives me a great deal of pleasure to meet with the Ontario Municipal Electric Association, with which I have been so long and happily associated and, of course, with the Association of Municipal Electrical Utilities. While my capacity as a delegate to this body has undergone something of a transition, I am more pleased than I can say that if anything my changed relationship has brought me closer, rather than otherwise, to this organization as a whole. Previously, and I hope in saying this I will appear not too selfish, my chief interest was in the welfare of my own municipality of Kitchener. This is understandable, and only as it should be. It is right and proper that a delegate should feel his strongest interest and exert his strongest effort on behalf of his own community. That is his primary purpose and function. As a provincial commissioner my interest is with Hydro in the Province generally, and if my recent appointment leads to nothing else it certainly will to broadmindedness and a broadened outlook.

As you know, my appointment with the Hydro-Electric Power Commission of Ontario is as yet of only short duration, but even in the few months in which I have enjoyed this new capacity I have come to a greater consciousness and realization than ever before of the magnitude, the magnificence, and the value of the Hydro system, municipally and provincially. Not only so, but I have come to an equal consciousness of the tremendous potentialities for mutual welfare offered by the Ontario Municipal Electric Association. The very frame-work of the Hydro set-up is fashioned with the instrument of

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**July, 1938**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

mutual effort, and based on an enduring foundation of municipal and provincial co-operation. Without a coming together of interested municipalities in the early days, Hydro could never have originated. Throughout the years its co-operative set-up has paid dividends of millions of dollars to its component members, and in time to come even greater benefits will accrue.

Now, as you are aware, my topic this morning is "Load Building"—a subject of many ramifications, and one which no individual, no matter how extensive his experience, is possibly capable of dealing with in any manner approaching completeness. All I can hope to do to-day is to give you some little insight into the hopes of the Provincial Commission, and by taking part in the discussion, to assist in some small measure the municipal representatives — and this is essentially a municipal problem—in coming to conclusions.

The first matter to be considered in a study of "Load Building," is the system's measure of progress, and by that I mean how far it has advanced towards the ultimate goal—absolute saturation. To my mind, all the indications are that Hydro has still a long, long way to go in this regard. As I read the signs, the system is just now emerging from a truly formative stage, and I will tell you why, in my opinion, this is so.

Through the years following its inception and until 1929 or 1930 Hydro was favoured with a consistent and satisfactory growth in load, year by year. Throughout this period new areas, new municipalities were being added and electrified. Except on one occasion during the past 15 years the average loads in municipalities and rural power districts in the Niagara system—(I take Niagara because it is the largest and accordingly from a general view most representative)—have increased year by year, and of late this increase has been very marked indeed.

Now let us, for a moment, consider just what that means and signifies. Before we can build loads, the growth potentialities must be there. That is to say, we must either procure new customers, or in the alternative our present customers must be capable of absorbing further quantities of power, else must our efforts be predestin-

ed to failure. In this regard, I personally feel assured that our saturation point is still some distance away.

Were we approaching the point at which loads would even out, the increases in latter years over their immediately preceding years would gradually taper. The tendency would be to settle downwards until a level had been reached at which, with slight variation, load would maintain. So far as Hydro is concerned, our recent experience has been just the opposite. Actually, since 1930, the first complete year of the depression, in which incidentally the average load of municipalities and rural power districts totalled 577,952.6 horsepower, this same average has increased by over 24 percent to a total of 719,262.9 horsepower in 1937. This, mind you, through a period of depression never before equalled in modern times. During that period the total number of customers per municipality increased not nearly so markedly. In 1930 there were a total of 415,738 customers — domestic, commercial and power, served by the local municipalities, and in 1937 the total was 452,517. While the number of customers has increased by 8 percent, the average load has increased by 24 percent.

It naturally follows, therefore, that the tremendous increase is traceable not so much to new customers, but to greatly increased usage of power per customer. Throughout the years our customers are coming to an ever-greater realization of the many benefits of electricity, and are utilizing energy in an ever-increasing number of ways. Its uses are increasing. Its utilization is becoming year by year more complete for household and industrial purposes — and this is important — even during the stringent years when the natural tendency is toward economy and reduced expenditure.

Now in the comparisons I have so far given I have drawn my illustrations from the Niagara system. It will, I am sure, interest you to know that the other systems have been equally active. In every area — in practically every municipality of the Province not only has the total use of power increased materially during the past several years, but the use per customer has increased in substantial amounts. What is true in the Niagara system is true elsewhere, and if the indications are as I have drawn them, then we may look forward to many more years of growth and expansion before arriving at what might be termed a saturation point.

Digressing for a moment, I might just say that it was largely this factor, enhanced somewhat by a complicated legal situation, that primarily influenced the Commission in its settlement last December with the Quebec power companies. We felt, and I think rightly so, that in expectation of the large increases yet to be realized in municipal and rural load, that we could not do otherwise than to provide in advance for power at the most reasonable rate possible. Every factor entering into the question actuated towards a speedy settlement. Dr. Hogg, in an address which I was privileged to read to you at your winter convention dealt with

the whole situation at length, and I will accordingly discuss it no further at this time, except to say that the conclusions he arrived at are heartily endorsed by both the Vice-Chairman and myself.

It is unfortunate but nevertheless unavoidable that when dealing with large power systems it is necessary to make provision for so many years in advance. Economic necessity requires that long-term contracts be entered into in order to secure fair and equitable prices, and at the same time to insure that ample reserves of power are available at all times for expected load growth and possible contingencies of any other kind. The advantage secured through moving rapidly last December will amount to approximately $92,000,000 within the Niagara system, but that advantage will be lost unless load continues to move upward sufficiently in large measure to overtake the additional deliveries.

It becomes obvious, therefore, that in order to render the system the safeguard which is necessary, that we must extend our efforts towards building load — and building load that will not deteriorate in the face of general economic conditions, but that will maintain in spite of what might be termed normal adversities. The potentialities are there—the possibilities for load growth and expansion—and we must utilize and exercise them to the best of our ability to do so.

In this regard it might be interesting to discuss for a moment the various factors that react against load expansion or, on the other hand, bring increases in load. It is inevitable that during periods of business depression power loads should decline. That is to say, faced with generally more stringent economic conditions and depreciating markets, industrialists must necessarily reduce their production in proportion, with a consequent reflection in reduced revenue to municipal and provincial commissions.

Permit me, for a moment, to refer you back to the comparison I have already given between loads in 1930 and at the end of 1937. That comparison, you will remember, showed a tremendous increase in municipal and rural demand during those years, and, I might add, an increase out of all proportion for the majority of those years with the increase to be observed when comparing between total load supplied to all customers.

Now, let us consider that very closely for a moment, and study its indications. During a period of economic disintegration — a period of industrial inactivity or virtual inactivity, domestic load has nevertheless consistently advanced. Wherein lies the explanation for this seemingly anomaly? Economic conditions would rather seem to exert in an opposite direction, because the earning power of our citizens, our domestic customers, their ability to pay, bears direct relation to industrial activity.

Several factors become immediately obvious. In the first instance, the cost of power has so reduced that the amount of money involved in reducing home takings to an absolute minimum is insufficient to offer an attraction—that is to say, to balance against the disadvantage and inconvenience that would result. The unavoidable tend-

ency is to economize in some less essential direction.

In the second place, it becomes increasingly obvious that due to the much more complete electrification of the home that it is impossible to maintain a domestic establishment in efficient operation without electricity.

Finally, referring back to the cost of electricity, it becomes obvious that many turn to electrical contrivances during depression in order to save both time and money.

And, in summing up, therefore, it becomes clear that while municipal load growth during periods of extreme prosperity must sometimes appear insignificant compared to the phenomenal expansion of industrial load, municipal load, based as it mainly is on domestic supply and demand, is more rigid and less prone to downward fluctuation. Once a peak has been established the probability is that that peak will be maintained and added to rather than otherwise.

Of the three factors I have enumerated perhaps the second — the increased utilization of electrical devices and the supplanting of other devices is perhaps the most important. It is not so many years ago that electric stoves were few, vacuum cleaners were perhaps not more common, and the sewing machine, the electric toaster, and the washing machine alone held sway. Since that time electric stoves and electric food mixers have come to occupy an increasingly important place in the modern kitchen. Vacuum cleaners have assumed a wide-spread prominence. Electric refrigerators have supplanted the ancient ice-box. Electric ironers now occupy a place of importance in the up-to-date home laundry.

More recently still, the problems of atmospheric control have yielded to scientific experiment. Air conditioning contrivances have resulted, thus making available an additional outlet for electrical supply. As each of these new devices were introduced to the popular market and received its approval, increases in load naturally followed. It is not inconceivable that in time to come electrical devices of a new and hitherto unknown nature will approach development, and it is for these that we must prepare.

The possibilities involved in an effective load campaign program have been well illustrated by the Commission and the municipalities in past years. In this regard permit me to refer very briefly to the water heater campaign which has been carried on since 1933 in most hydro municipalities, resulting in enormous increases in the number of water heaters in use, and a considerable and continuous increase in load. It is only by a consideration of the measure of success resulting from past effort that we may reasonably plan for the future.

It will, I am sure, interest you to know that since 1933 there has been installed under our co-operative heater campaign, 42,140 flat rate heaters and 16,200 booster heaters. During the fiscal year 1937 these installations resulted in the absorption of an average of 35,100 horsepower, and as a result the municipalities of the Province saved in power costs—because even had the power not been sold it would still require to be paid for—a total, in one year alone, of

$526,500. The total estimated relief for municipalities in power cost up to October 31st, 1937, and including that period since 1933 has reached the very surprising sum of $1,567,170. The total capital cost of the heaters to date as billed to the municipalities is only $1,450,000. Against this, permit me to point out that during the four years up to December, 1937, the municipalities collected in revenues from water heater installations a total of $3,133,212.

Equally spectacular results have resulted from the range campaign. During 1937, 100 municipalities participated in this co-operative effort, and as a result the number of ranges installed for the year increased by 25 percent, from a total of 6,101, as inspected by our Electrical Inspection Department in 1936, to 7,591 in 1937.

So far this year, the response has been even more promising. To date 210 municipalities have been contacted, in one manner or another, and of these 145 have already entered the campaign and are at the present time actually participating. Very nearly half as many again as last year, so that, all things being equal, we might reasonably look towards an increase during 1938 of perhaps as much as 50 percent in the number of installations over 1937.

It is in the direction of these two campaigns — water heaters and ranges, that the most intensive effort has in the past centred, and it is in this direction, as a result of that intensive effort, that the greatest measure of success has been obtained.

All in all, the future is bright and full of promise, providing the various jurisdictions entering into the supply of power, co-operate to the extent of their ability for mutual betterment.

So far as the Commission is concerned, every effort will be made to enhance the present campaigns, and to further them in every possible way. Not only so, but plans are presently under consideration providing for the extending of the scope of our sales and promotional department, with a view to advancing into those fields in which a lesser measure of success has been obtained in the past.

The two programs in which the largest measure of success has so far been attained provide a most interesting indication of what can be done, despite certain factors which inevitably react against them. Consider, for a moment. Each installation — whether it be a water heater or an electric range, calls for a capital investment. No matter how the cost of the equipment is spread, or divided, inevitably it reacts against the consumer. Nevertheless, despite that drawback—and it is a very real one—considerable success has been attained. I ask you, then, to consider the potentialities for load growth which reside in a scheme requiring a much smaller capital investment. I refer to the possibilities for load growth involved in a really effective lighting campaign.

It is unfortunate, but nevertheless true, in this day of scientific enlightenment, that 40 percent of the young men and women of college age have defective eyesight. Even among public school children, 20 percent are affected in some manner or another, and

above the age of 60 at least 95 out of every hundred suffer from vision impairment. That perhaps the true cause for this disgraceful condition lies primarily in insufficient and improper lighting would seem well-established in scientific fact. It has been determined that an hour's reading, under improper lighting conditions, provides sufficient strain to actually reduce the heart action by five times as much as an equivalent exertion under proper lighting.

Further unimpeachable proof lies in studies conducted among the various vocations. Among farmers and labourers who spend the greater part of their day outside in natural light, the ratio of eye disorder is extremely small. It is the stenographers, the draftsmen, the students, who suffer most—the office-workers, and the professional men, whose work consists of much reading. As high a percentage as 80 percent of these have defective vision. Even among housewives the percentage of those with poor eyesight has been established at 60.

And eyesight is not only a matter of personal satisfaction—it is a matter of personal efficiency and progress. From 1933 to 1936 a survey of schools was kept in Alabama to determine the effect of light on students. It was established that in poorly lighted school rooms an average of 27 students failed to pass their examinations over a period of three years. Under proper lighting conditions within a similar period only 9 failed. Even allowing for a possible variance in the ability of the students, the comparison speaks for itself, and in a manner which permits of no misunderstanding. It is a fact that lighting in our homes, our factories, our stores, our places of business and even in our schools of learning and educational institutions is woefully inadequate—hopelessly inadequate—a disgrace to the age of enlightenment in which we live.

The potentialities for actual public service as well as the possibilities of financial return in additional sales of power in this direction are immeasurable, so far as the municipalities of the Province are concerned, and I would ask you that you give your most serious consideration to this matter.

So far as the water heater campaign is concerned, all the present indications are that 1938 will prove as successful a year as 1937.

The range campaign is proceeding, as I have stated, with vigour and marked success. The Commission's Radio Cooking School, conducted in conjunction with this campaign, is evoking satisfactory comment from all parts of the Province, and it is our hope since the season closed on June 29th to reopen in a much broader way about the middle of August.

So far as lighting is concerned, the Commission has hopes of launching within the immediate future a much improved campaign, based on the present one, but much extended. The difficulty with which we have in the past been faced in this regard is in the procuring of competent demonstrators. This is a new sort of work, and one which special training is a necessary adjunct to the achieving of real results. At the present time we have one squad travelling about the Province, and it is our hope to equip a number of others in order that the

Province may more effectively be canvassed. The Commission is prepared to play its part in bringing about a more effective use of electricity within the Province.

It is essential, however, in order to achieve success in an endeavour of this nature that the municipalities cooperate, and extend their efforts in a parallel direction. In many respects the local authorities are best competent to investigate and advise. Local conditions govern the activities of each municipality in promoting the use of more power among their consumers, and there are innumerable factors which regulate the extent to which promotional effort will succeed. The direction in which advertising and publicity is aimed must, in order to be effective, vary in different localities according to different situations. You may be sure that not one municipality of the Province can boast of having more than barely scratched the load-building possibilities within their area. The point of saturation is still so far away that we cannot even see it. The possibilities for financial improvement to both jurisdictions are immeasurable.

Let me just indicate to you a few of the ways in which the municipalities can assist. Primarily, load building is, because of the factors which I have mentioned, a municipal matter.

So far as the range campaign is concerned, the Commission is more than pleased at the very favourable response to our suggestion that local utilities take upon themselves the financial burden involved in substituting three-wire for two-wire services. Of the 144 municipalities engaged in our range campaign, 132 have agreed to either wholly or in part absorb this additional cost, which otherwise would react directly against the consumer.

About 60 municipalities have definitely decided to undertake home servicing of consumers' appliances and equipment, and a number of others have not as yet come to final decisions. I would urge to the extent of my ability that those of you who have not already come to this decision take it under advisement. For every electrical appliance that remains idle because of breakdown or failure to function efficiently, there is a loss of load. Few housewives make it a point to repair equipment immediately it requires it. Sometimes days or weeks will elapse before it is again ready for service. During that period a potential load is lost—a load which once was supplied. Not only so, but during that period there is always the possibility—and sometimes a not too remote one, that dissatisfaction will cause the consumer to supplant the electrical device with one of some other type.

One example of what can be achieved in this direction is afforded by the City of Windsor where despite somewhat higher per kilowatt-hour rates than in some of the other large municipalities, and in the face of intensive competition from gas, the average monthly domestic consumption has multiplied by approximately two and one-half times within a period of 15 years.

So far as lighting is concerned, the major portion of this work must necessarily be undertaken by the municipalities themselves. The Commis-

sion is prepared to undertake studies and to train officials for work of this nature, but in the final analysis, because of varying local situations, the local utilities must take over the major portion of this work.

The possibilities in commercial lighting alone are immeasurable, and a systematic canvass by the local utilities of their various customers with a view to improving lighting conditions within their stores, factories and other industrial premises should alone be productive of immediate and lasting results. On grounds of efficiency alone, no factory owner can afford to neglect proper lighting. So far as retail stores are concerned, tests conducted in Hydro shops where emphasis has been placed on showcase and window lighting during past years provide a striking example of financial benefits which can result—and in a manner which the storeowner cannot help but recognize.

It is our hope that in time to come an ever-increasing number of local utilities may find it possible to join with us in our "Better Light" campaign, and reap the benefits along with those others who have in the past co-operated in this regard.

A most important point in selling additional power, and one which cannot help but appeal to any consumer, is that the cost per kilowatt-hour tends to decrease as the amount of power purchased increases. The use of twice as much power as formerly does not mean twice as high a bill. In local promotional effort this point should be emphasized—that a great deal more power, greater home comfort, greater convenience and domestic satisfaction, can be procured for only a very small increase in expenditure.

Hydro is now, perhaps, in a better position than for many years past. The difficulties with which we were faced during the depression — the steady increase in power costs, in some systems the mounting deficits, increased thirteenth bills, and enforced stabilization of rates from reserves, have been overcome and very advantageously. Rates are now lower than they have been for many years, and of all selling arguments this is perhaps the foremost.

This has been well-illustrated in the Commission's operation of the rural power districts. In the past, the service charge has reacted against rural expansion. The fact that the consumer was required to pay up to as high as $8.30 per month before starting to pay on consumption, exercised a retarding effect for many years. During the past three years tremendous strides have been taken in this direction. Service charge reductions were granted on three separate occasions, totalling savings to rural consumers of between $600,000 and $700,000 per year. Wide publicity was given to these reductions, and as a result the increase in rural customers and in rural usage of power has been truly phenomenal.

During the fiscal year 1937, 2,300 miles of new rural lines were built or projected, to serve 13,000 new rural customers. It is interesting to note that this program exceeded by 50 percent the construction of line and number of customers added to the systems in the previous most successful year, 1930. In that latter year 9,375

customers were added and 1,893 miles of line were constructed. As a matter of fact, more primary line was constructed in 1937 than in the four depression years of 1932-3-4-5 together.

To the Commission's view, these truly phenomenal results are directly resultant from two factors. First, the very aggressive campaign which has been conducted in the rural areas, and secondly — and this is perhaps the most important, the very considerable reductions in charge. The latter item speaks for itself, so long as sufficient publicity is given to it.

So far as the municipalities are concerned, the possibilities in this direction are equally promising. During the year 1937, every organized system of the Province received rate reductions and refunds, in total amounting to over $3,400,000. In order to secure maximum productivity the municipalities must publicize the present low rates within their confines, as the Commission publicized low rates within rural Ontario.

There is such a very, very great deal that can be done with a system such as ours. The potentialities for public service are unlimited, providing both jurisdictions, provincial and municipal, enter together into the great work we are undertaking.

There has been nothing technical in my few remarks to-day. I did not intend that there should be. My thought was to give a short review of past success in "Load Building," in order that you might be made aware of the result of mutual efforts in this direction, and at the same time to indicate to you in some slight measure the Commission's attitude with regard to this matter, and our hopes for the future. We are willing to go more than half way in combining wherever possible to make local promotional effort successful. I am more than pleased to express the Commission's willingness to meet with local utility operatives at any time in order to assist in working out local problems, and to receive your suggestions as to how we may further your plans. That is our purpose—and it is a purpose we intend to serve to the extent of our ability. It must, on the other hand, be the purpose of the municipalities to avail themselves of whatever resources we have to offer—as many of you already have—and to exercise and utilize those resources to the general benefit of the consumer we both serve.

Surely there is unity in our joint desire to produce power and supply it to the consumer as cheaply as it is possible so to do. In this regard the operations of each individual municipality exert a strong influence on the cost of power in all other municipalities. Mass production tends toward a reduced cost of individual items, and any increase in the supply of power within any one municipality tends towards a levelling downward of the average per kilowatt-hour charge throughout the system generally. On the other hand, for every kilowatt-hour that remains unsold, a charge must nevertheless be made against the municipalities generally. Whatever power remains unsold exerts in two directions. Not only is there wastage involved in the production of that power, but its cost is added to that of

power already being sold, with a consequent retarding effect on power sales. It is truly a vicious circle — ever-widening and expanding.

Much has been done in the past, but much remains to be done in the future. It is only by a mutual understanding of problems, a mutual willingness to stand together on matters touching the welfare of all, that the maximum benefits of our gigantic scheme may be procured for the power-users, on whose behalf we operate. So soon as all jurisdictions entering into this great scheme come to a true awareness of these factors, then and then only will Hydro really come into its own.

Despite the forces that react against it consistent effort and an attitude of give and take can enhance this mutual understanding and endeavour. Too often we hear the cry of "Hydro in politics," and when we do there comes a natural inclination to those of us who are Hydro-minded to rally to one side or the other of the political fence, and sometimes to take up the cudgels for we know not what.

So long as the municipalities and the Provincial commissioners stand firm in service to the people, Hydro has nothing to fear from politics. Despite numerous investigations—and there have been many in the past and will probably be more in the future—in this regard it seems inevitable that an organization so prominent as ours in service to the people should bask in the glare of public attention—despite the campaign of vilification that has been directed from time to time against not only various individuals in control of affairs but also against the system—the scheme—the organization itself—Hydro has withstood the forces of disintegration, and Hydro will withstand those forces in the future. I can assure you with all sincerity that it is my fondest wish and desire—as I am sure it is your fondest wish—that this should be so.

# Applied Science From the Viewpoint of an Electrical Engineer

**By W. B. Buchanan, Testing Engineer, H.E.P.C. Laboratories**

*(Presented to American Association for the Advancement of Science at Ottawa, Ont., June 27, 1938.)*

THE letter of invitation from the secretary of this branch indicated that a wide range of choice of subjects would be permitted, also considerable latitude in the discussion of any chosen subject. After some consultation as to what might be considered the aims of such an Association, it was believed that illustrations from the practical field of Electrical Engineering might be discussed with mutual interest and profit and various problems suggested could be included under such a title as has been adopted.

As a group of people interested in science and scientific methods, we have mutual problems and it will be convenient for me to discuss these problems in a sequence leading from the broader aspects to the more intimate and highly specialized.

We all have obligations to the general public from the point of view of education, also as to protection,—life, fire and financial.

Sometimes we are inclined to forget that a great mass of people are not scientific minded. Some have no conception of the methods and processes by which definite knowledge is obtained.

A stone mason's helper once started conversation with me by saying,—"That thing (a carpenter's two-foot rule) is something I've never been able to understand." His attitude was one of awe and almost reverence. His education probably had never progressed to the simplest elements of mensuration and as he observed the mason measure, cut and set his work according to the dictates of a two-foot rule, that rule assumed the role of a magician's wand, the visible token of something mysterious and powerful beyond his reckoning.

But this attitude is not the only one confronting the scientist. You are probably all aware of groups to whom scientific activity is merely superficial phenomena; whose training is largely one of inexact thinking and to whom conduct is even less approximate. The barrage of talk set up at times by such erudite groups recalls the comment of Jules Verne—"And once again Wit triumphs over Science." My comment in this matter is simply that we all—electrical engineers included, should be interested in the inclusion in our educational curriculums of a reasonable amount of training in the exact sciences and scientific methods. No amount of care or effort on the part of electrical engineers or any other scientists can fully protect the public from the consequences of their own ignorance or follies.

Another scientific service rendered

by the electrical engineers to the public in a practical way is watchfulness against fire and life hazards which might result from the use of electricity.

About twenty years ago the question was raised in a group of representative electrical engineers as to what the attitude of the group should be toward the exploitation of the public by the supply of hazardous devices. One speaker expressed the view that as gambling is a fundamental impulse of human nature, the public should be left to take care of itself. Illustrations were given to show that it was no question of a gamble but a certainty of loss of life with some of the equipment being marketed. Another speaker very carefully pictured the difficulty and embarrassment that might be involved were individuals, or small groups, to undertake to protect the public and expressed the opinion that such service should be undertaken by some body having great powers of endurance and in a position to take official action.

The latter view has gained favour in public opinion and legal status has been given in support. At the present time in this province the time-honoured principle of "caveat emptor" is rapidly being replaced by the more modern dictum, "let the *seller* beware" in the matter of distribution of electrical appliances for domestic use.

Another type of public service rendered by the electrical engineer is related to financial protection.

I have in mind a request from a stockbroker to report on a new type of storage battery container for automobile use. There seemed to be no doubt that a complete battery would show good performance tests on the standard charge and discharge test but the question of the life of the battery would depend on the resistance of the material of the cells to acid-penetration.

One cell was filled with distilled water, an adjacent cell with standard acid. Twenty-four hours later the distilled water indicated a substantial amount of acid.

The broker's comment on receipt of the report and invoice was that he considered his money well spent. The manufacturer, however, started production, presumably from funds raised elsewhere. An eighteen months' guarantee was given the product and in about that length of time the company conveniently went insolvent.

This is a true story from a journalist's point of view. It serves to illustrate in another way how the electrical engineer applies his scientific knowledge and methods to the financial welfare of the public.

As a group we also have problems involving co-ordination of effort. The engineer is encharged with an undertaking and he must derive from his own experience or with the aid of one or more expert assistants ways and means of performing all that is essential to that undertaking.

It is extremely important that he exercise good judgment as to when to defer his own opinion to that of some proven expert in a special line. The field of applied electricity is so extensive that trends of thought and

habits of practice may readily be carried beyond the bound of economical application. For example, an engineer whose early training and experience has been with electronic tubes and comparatively minute currents favours the methods he is familiar with even to those applications where rotating machines have a decided economic advantage.

Association with workers in other branches of science requires a co-operative spirit. From an engineer's point of view the division into branches is in many cases quite arbitrary. His final criterion on the merits of devices or equipment is its actual performance, not who built it, or sold it or how much time or expense had been put into its design or fabrication.

That the final dictum of applying scientific knowledge pertaining to his field rests largely with the engineer seems to be generally accepted and to be able to persuade the engineers to make application of the results of their work is the ambition of scientists working along supplementary lines. An attitude which seems to me to indicate a very fine spirit of co-operation may be observed by reading the titles of five papers being read at one session of the Summer Convention of the A.I.E.E. at Washington on June 21, 1938. It would appear that definite attempts are being made to present the material so that the engineer may assimilate it with the least difficulty.

Another reference of earlier date serves to indicate the supplementary relation of the various branches of applied science, and reads thus: "If electrical engineers will come forward, as my co-author has done, with a statement of what the electrical industry requires, the plastics industry will not be slow to develop suitable materials."

The problem of the newly graduated student adapting himself to the practical application of his newly, and perhaps we should suggest, partially acquired knowledge is one upon which volumes have been written. It is not our purpose to indulge in platitudes nor repeat principles of study which can be more effectively discussed at other times and places. We prefer rather to illustrate, by means of some typical problems, how an engineer, being faced with some responsible undertaking, utilizes the various means at his disposal, from whatever source and of whatever nature may be necessary to accomplish his purpose in a technical sense.

### LIGHTNING—EXTERNAL AND INTERNAL

The problem of harnessing lightning has been an extremely practical one and very important advances have been made during the past twenty years. Previous to that time little had been known of the actual energy involved in lightning strokes and a great deal of speculation was indulged in for lack of quantitative data.

One of the most useful devices for studying lightning phenomena is the Klydonograph. As a measuring device, it is altogether too crude to have any academic status, nevertheless, it can be made to serve very useful purposes in recording over-voltage phenomena of various kinds. It is based on the fact, known for

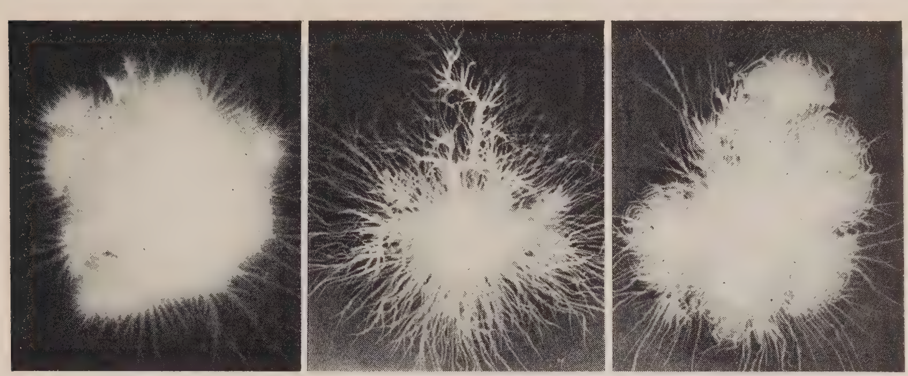


*Fig. 1—Klydonograph records. Examples indicating very steep wave-fronts.*

more than a hundred years, that an electric potential applied at a point on a sensitized (photographic) plate or film would register an image giving some measure of the magnitude and duration of that potential. On this principle a large number of very inexpensive recording devices were made and arranged to record over-voltage surges on a 220,000 volt transmission line. Some records obtained are reproduced and certain deductions may be made from the nature of the images indicated.

Records taken in the vicinity of the stroke show images, such as in Fig. 1, indicating very steep wave-front. After the surge has travelled some distance along a conductor the wave-front becomes somewhat less steep and the images resulting are more distinctly radial rays, Fig. 2. They also become of lesser length with increasing distance, as indicated by Fig. 3. This line was provided with steel towers and two overhead ground wires and simultaneously with the stroke registered on the power con-

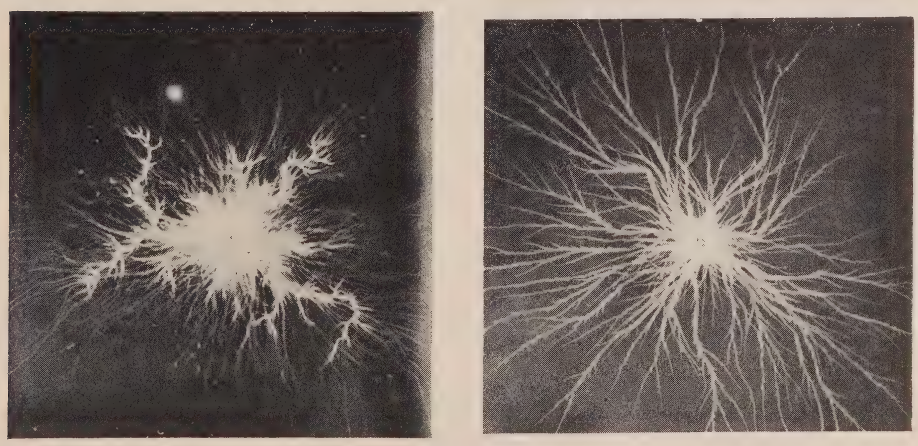


*Fig. 2—Klydonograph records. Example indicating flattening of wave-front in 1.1 miles.*

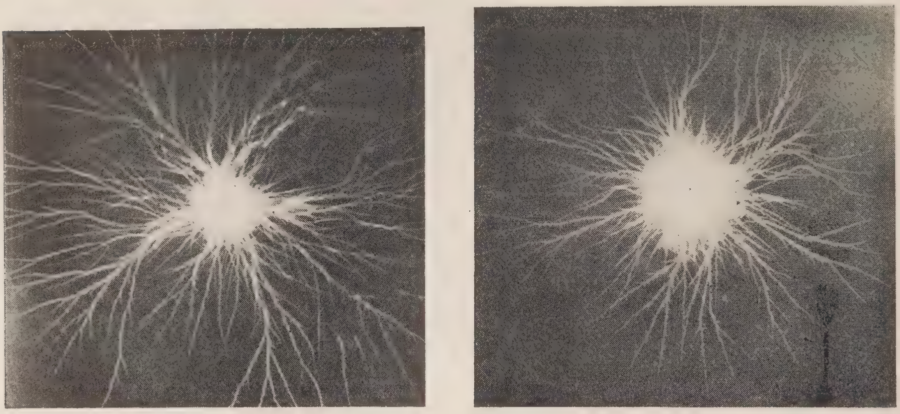


*Fig. 3—Klydonograph records. Example indicating attenuation in 1.1 miles.*

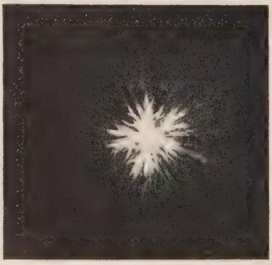
ductor a discharge was registered from the foot of the tower to a point about 30 feet distant about 12,000 volts being built up across an earth resistance of 4 ohms, Fig. 4.

Various methods of coupling to live lines may be used but the Klydonograph requires so little energy that a capacity (electrostatic) coupling is most commonly used. Insulator strings of suspension units may be used but during wet weather the ratio of line to registered voltage may be quite erratic.

A type which has proven satisfactory is a pipe type capacity potentiometer with the pipes mounted vertically. Views of two practical applications of such type are indicated by Fig. 5—A and B.

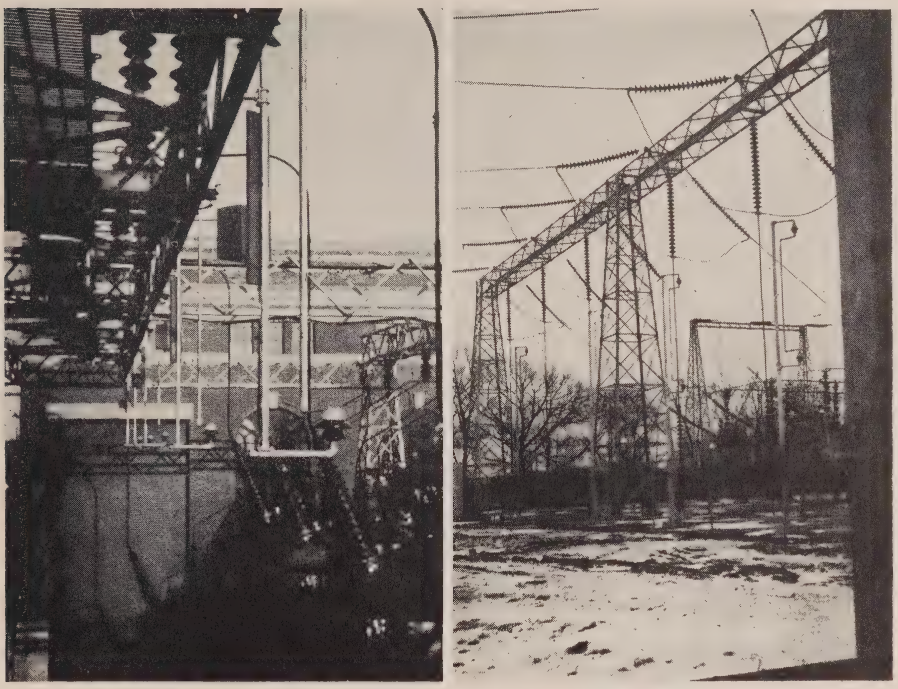
While atmospheric or external lightning is most spectacular, the electrical engineeer has to consider also what is frequently called inter-

*A*



*B*

*Fig. 4—Klydonograph records.*
*A—Record on power line conductor.*
*B—Potential tower footing to earth at 30 ft. distance. Indicated voltage approximately 12,000 volts.*



*A* *B*

*Fig. 5—Potentiometer Connections for Klydonograph.*
*A—Adjacent to a transformer bushing.*
*B—From 220,000 volt overhead line to ground.*

nal lightning such as may arise from switching surges or other violent disturbances in electrical circuits. Switching frequently gives rise to surges three times normal line-to-ground voltage and occasionally as high as five times normal. Cases, very special, are on record where voltages in excess of 4,000 volts were induced on 110 volt lighting circuits due apparently to very high speed switch operations.

A valuable aid in the study of high frequency high voltage phenomena introduced more recently is the cathode-ray oscillograph. With its aid, highly trained mathematicians have been able to check the expressions derived theoretically against the actual performance on the lines and thus provide a reliable basis for computation of the performance of projected lines.

The magnitude and nature of the over-voltages on a high voltage line dictates the character and amount of insulation necessary to ensure continuous service. Factors of safety must be adopted to provide such service and the cost of equipment rises rapidly with the factor of safety adopted. Like many other factors the engineer uses, this factor must be based largely on practical ex-

perience as most of the components involved cannot be estimated accurately on a theoretical basis.

Grading of the insulation strength from line in to the station equipment has been discussed more frequently during recent years and quantitative data have been assembled on such component parts as, impulse factor for various types of insulation, striking voltage between terminals for different shapes of terminal fittings, velocity of travelling waves, etc. The general purpose of the application of such studies and data is to avoid breakdown of insulation at a location, e.g. in a transformer winding, which would be very expensive to repair and involve long periods of time of outage.

Assuming the initial design and construction of a transmission system to have been perfect, the problem of maintenance is always present.

Ageing of insulation, weathering effects, in addition to other less tangible influences may introduce quite unexpected results.

A 132,000 volt pillar-type insulator of the type indicated in Fig. 6 was blown up in service, cracking the concrete foundation to which it was bolted. A study of the dielectric stress distribution was made by applying high voltage to a similar insulator in the laboratory. High concentration of stress was shown as indicated by the static streamers, Fig. 6—B, in fact one such insulator punctured through the porcelain at the head. Normally the striking-distance on the surface, either interior or exterior, should have been ample to withstand the potential applied and

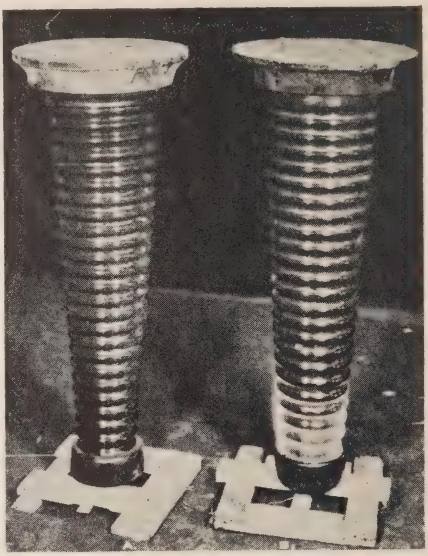


*Fig. 6—Dielectric Flux or Gradient Control on Insulators.*

leakage on the interior was suspected, presumably due to moisture. Insulator, Fig. 6—A, was wetted up the interior and the result indicated by Fig. 6—B obtained. Unit B was dried out by internal heat and results similar to A obtained. Provision was made for keeping such units permanently dry in service.

On another occasion an insulator of similar type but mounted horizontally about eight feet from the floor on inside construction, shattered and fell to the floor. The broken sections showed a large percentage of radial fractures and the inner surface, rather than the outer, showed evidence of power arc. Apparently the destructive flash had taken place through the centre of the pedestal.

The base of the insulator was open and mounted on the back of a channel-iron section. Careful in-

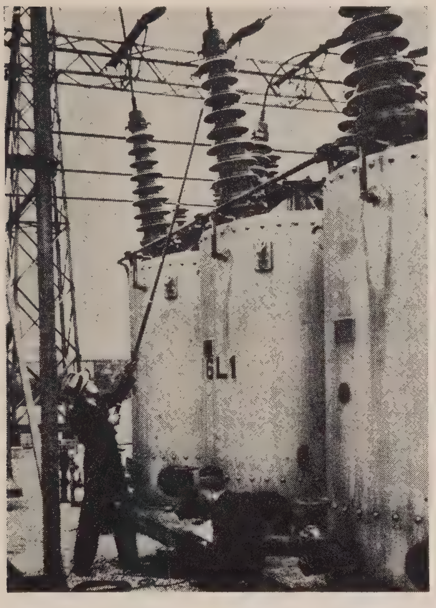



*Fig. 7—Checking gradients in high-voltage bushings by direct measurements.*

spection indicated a slight amount of straw or grass quite foreign to such location near the base of the insulator. Further close inspection showed that six of seven remaining insulators in similar locations contained birds' nests. It was surmised, on circumstantial evidence, that birds had seriously disturbed the potential gradient of the insulator.

These are illustrations of the contrast frequently afforded between practical science from the viewpoint of an engineer and the academic or theoretical aspects taught in formal courses of instruction.

Further practical need exists for information as to the condition of insulation particularly where the live conductor is carried through the insulating medium such as bushings. Energy loss and power factor measurements have been used but it can be shown that a bushing may be on the verge of failure without an appreciable increase of power factor, also that a substantial increase of power factor can be obtained without any increase of hazard, such tests can hardly be regarded as giving a perfect criterion of the serviceability of an insulation.

As a result of experiences such as the foregoing, a gradient method was suggested and the various means of checking such gradients carefully considered in relation to their applicability to this purpose. A direct reading method was finally adopted and has given very excellent results in maintenance work.

Fig. 7 shows the manner of actually taking the readings involved in these tests. As it is essentially a live-line method no interruption to service is required, the time per unit is reduced to an insignificant amount and the results are highly informative.

Curves shown in Fig. 8 are representative of the data obtained by such a scheme of tests. Line voltage is indicated as reading 100 percent, a good insulator giving curves lying approximately within the hatched section—while those having faults in incipient stages are detected by curves such as Fig. 8—A and B.

In the early stages of the study the doubtful feature of the problem was as to whether a sufficiently sensitive measuring device could be obtained to give any reliable cue as to the gradient beneath a porcelain shield which in some cases exceeds an inch

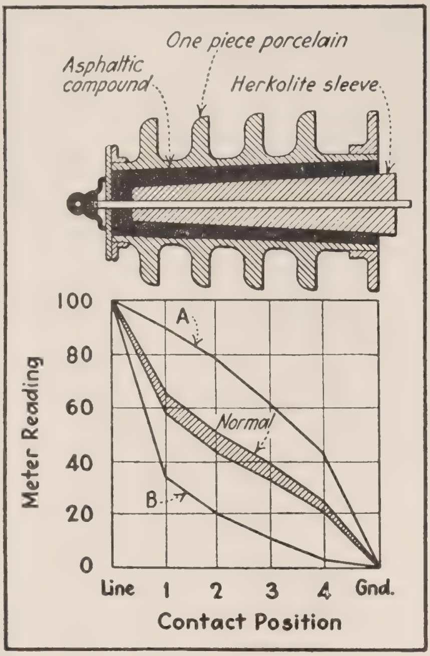



*Fig. 8—Typical Results of Gradient Tests on Oil Switch Bushings. Voltage gradient curves showing location of leakage paths in 26 kv. bushing. A—Moisture in upper part of bushing. B—Moisture in lower end of bushing which failed in service two months after test.*

thickness. It has, however, been shown to be quite possible and methods of applying corrections to compute the true open circuit potentials have also been devised.*

It would be interesting to review briefly the various features requiring consideration in a study of what is known as the "Stability of Operation," of an interconnected system of generating and distribution stations, some of the latter involving synchronous apparatus. Time, however, will only permit a suggestion as to some of the salient features.

At the generating station the inertia of the prime movers, the rate of governor response and its effect on the power input must be considered; also the synchronizing power of the generators singly and, in groups, with and without additional reactances. This would be difficult enough under stable conditions but under transients, such as may occur on accidental short-circuits, other factors such as mechanical and electrical phase-displacements occur and the transient phenomena of field control is also a factor.

Combined with these is the impedance of the inter-connecting lines or networks. Problems along these lines have occupied the attention of expert mathematicians and engineers for several years and the calculations involved have warranted the construction of very expensive calculating boards and machines.

I mentioned that, practically, the engineer regards the subdivision of science into branches as somewhat arbitrary. Frequently, because electrical methods of measurement are so flexible and sensitive, and the methods of analysis in common use of such a general character, the electrical engineer can make himself useful in other than purely electrical fields.

An illustration of how this type of co-operation can be applied is given by a study of the conditions involved in the suppression of vibrations which frequently occur on transmission line conductors, due to wind blowing across the line. Failures of

*A more complete discussion of this problem may be found in the Bulletin for November, 1937, pp. 387-346 inclusive.

*Fig. 9—Vibration of Line-conductors —Equipment used in field for attenuation tests by travelling wave method.*

conductors have occurred at suspension clamps attributed to the bending stresses superimposed on the static tension as the result of these vibrations.

Since one transient component of stress is due to bending, it seemed desirable to have a device which could measure and record if possible under field conditions the curvature of the conductor at any point desired, and it was necessary to design such a device. Step-by-step a recording apparatus as shown in Fig. 9 was assembled and its practical use has clarified many important questions re line vibrations. Essentially it consists of a pair of carbon-packs in the plane of vibration being studied and, normally, about 1 ohm each. These are connected in two arms of a Wheatstone bridge arrangement, adjustable resistances in the other two arms and an oscillograph connected in place of the usual galvanometer for recording purposes.

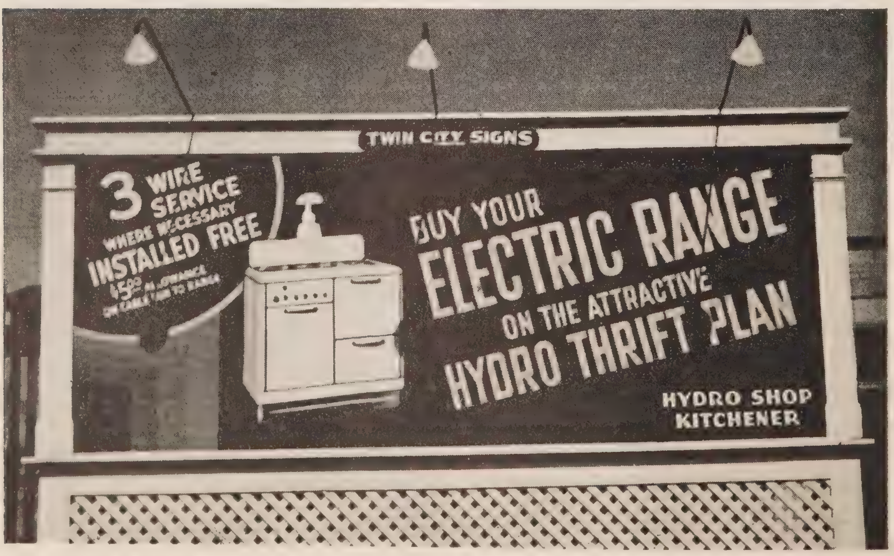
With this apparatus it is possible to record the reflected and transmitted components and the attenuation of a wave mechanically applied. Since the radius of curvature of such a conductor involves a derivative of the second order, the record gives a measure of the energy content of the wave and hence a means of determining energy absorption or loss. Hence a direct method of comparison of the effectiveness of various damping arrangements can be made and the scheme has been used for

*Fig. 10—Mounting a curvature recorder on a line conductor in the field.*

this purpose. Considering that the entire problem is in the investigational stage, remarkably good agreement has been indicated between the results of such field experience as is available and what would be predicted as the results of a judicious application of the data obtained from tests such as those referred to. Fig. 10 illustrates a test-man mounting a carbon-pack curvature recorder on a line conductor and making preliminary adjustments. All other adjustments as well as the recording are controlled from the ground by means of the equipment shown in Fig. 9.

The field of electrical engineering as a special branch is comparatively new. As a consequence, a new-comer studies the subject from modern texts and probably, with some justification, feels quite well posted. A tendency, however, is becoming apparent to revive practices purporting to be new, but which have been tried out and abandoned for various reasons in former years.

Having such observations in mind, I would like to suggest in conclusion that the electrical engineer may and probably would find practical use for historical reviews of the special branches in which he is interested. It would appear that as time advances the need for reference to the historical phases would become more and more urgent if continuous progress is to be made, and a cyclic order of failures and successes avoided. Such summaries could also be given a fair share of romance, in fact, the romantic features of developments in electrical engineeering appear to be unlimited.



# Electricity on the Highway

By R. E. Jones, Assistant Engineer, Distribution Section, Electrical Engineering Dept., H.E.P.C. of Ontario

*(Presented to the Ontario Municipal Electric Association and the Association of Municipal Electrical Utilities at Bigwin Inn, Muskoka, July 6, 1938.)*

THE ever-increasing use of motor vehicles with the higher speeds common now has necessitated the development of numerous devices to reduce the number of accidents, especially on the new super highways where traffic is very heavy. Electricity is doing a large part of this important work; telling you when to stop and when to go; how to get to your destination; and at night furnishing a passable substitute for daylight.

To the road authority electric power helps to solve many problems. To the electric utility the modern highway offers a potential market for large blocks of power, much of it off the peak for a large part of the year. In probably no other way can the utility obtain such a load with as little investment in plant.

## ROAD LIGHTING

The majority of motorists use the roads during the hours of daylight. Night driving is done usually from necessity or to avoid the congestion of the daytime. At night there is the glare of approaching headlamps, the difficulty of seeing objects on the road, and the nervous tension due to the limited field of vision with headlights. These factors result in many times the percentage of accidents at night as compared to daytime.

Add up the cost of these accidents in property and add something for damage to persons, although this latter loss is impossible of valuation, and you will have a sum of money that would pay for a lot of road lighting.

Then again if long stretches of road were well lighted many motorists, particularly the tourists, would travel during the night. This would have a considerable monetary value due to it increasing to a large extent the capacity of the road, or to express it electrically, "improving the load factor."

It is better to light a short piece of road well rather than spread the available funds over a lot of roads. Records show that a poorly lighted road is more dangerous than a road without any lighting. Any attempt to light a piece of road with insufficient funds is a waste of money and effort and the poor illumination will discredit any road lighting in the district for some time to come.

Many details of construction of a lighting system will depend on local conditions but there are some fundamentals which must be adhered to.

The lighting of any road may be done in either of two ways. The

candlepower used may be very high and objects are observed by reflection. In other words objects are seen by light from the lamp being reflected from the object to the eye. The colour and other details of the object are thus observed. The location of the light source is not of great importance provided it does not cause a glare.

On the other hand if only a limited candlepower is available seeing of objects on the road is by silhouette. The light from distant lamps is reflected from the pavement to the eye. Any object between the eye and the multitude of points of reflection on the pavement is seen as a dark outline.

In a city we are interested in the colours of buildings and of clothing on people. On a highway we only desire to know a person or other object is present and what its motion is and a silhouette gives us this information with the minimum expenditure of light.

Last Autumn the Department of Highways of Ontario decided to light the "Cloverleaves" and bridges on the new Middle Road between Toronto and Hamilton. The Hydro Electric Power Commission was asked to lay out a suitable system and to proceed at once with its installation.

It was decided to use 500 watt incandescent lamps in Holophane highway luminaires supplied from a multiple circuit and controlled by a time-switch and relays.

Experience elsewhere has proved the soundness of the Illuminating Engineering Society's rule of the ratio of spacing to mounting height of 8 to 1 as a maximum. This standard was adopted with a mounting height of 25 feet and a spacing not in excess of 200 feet. This spacing was seldom reached due to the curves in the roads of the Cloverleaf and also the necessity of placing lights in the proper relation to danger points. Also on the bridges the posts with their outlets had already been located by the design of the bridge and frequently not at a point most desirable for illumination.

Due to the method of lighting a roadway by the light reflected from its surface as already described it is necessary that the light source overhang the pavement. This was set as a rigid standard of 3 feet. As the road authorities had given a location of 12 feet from the concrete for poles, a 15 foot mastarm was used. This was built of a welded steel tube with a trussed compression brace.

Poles were of Western Cedar shaved and painted except on the bridges where steel poles of ornamental design were used. The poles were given a sand collar creosote treatment and also numbered with aluminum figures.

Single conductor rubber and lead covered cables were used, buried 2 feet below ground and carried beneath pavements in 2 inch pipe. Cables were No. 4 B & S to give a maximum voltage drop of 5 per cent. and were spliced and tapped in cast iron boxes with covers which were later filled with asphalt. The lead up the pole consisted of No. 8 single conductor rubber and lead with the lead sheath acting as the grounded

*New 4-lane Middle Road showing lighting on either side.*

*Two-light pole on 30-ft. centre strip. Mastarms 18 ft. long.*

side of the circuit. It was attached to the pole by a wooden ground wire moulding and was continuous from the splice-box to the luminaire.

After this work had been completed the Department decided to light the 4 mile stretch of the Middle Road between Browns Line and the Cloverleaf and also to install an experimental piece on one lane for a half mile near Sheridan.

The former road consisted of partly a 40 ft. pavement and the balance with 2 20-foot lanes with a dividing strip a few feet wide.

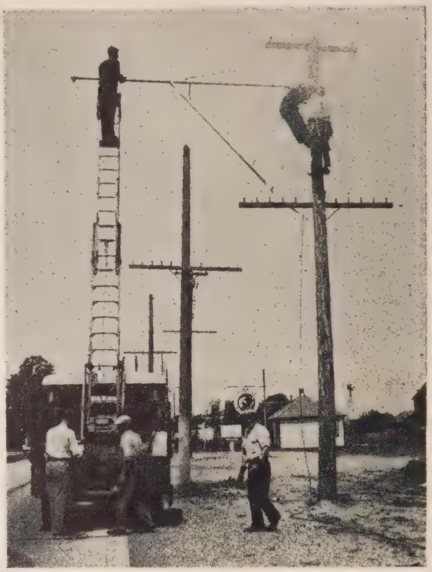
Poles were erected 200 feet apart on each side in a staggered arrangement. They were erected in the same manner as already described for the Cloverleaf except that overhead conductors were used wherever possible.

In general the construction was as already described. For control of the circuits one time-switch was used with a control wire to actuate the relays at each transformer. The relays were of the circuit opening type whereby the control wire is alive in the daytime. Thus any damage to the control wire at night will not interrupt the supply to the lamps. Using 500 watt lamps and No. 4 copper a transformer was necessary each 3,200 feet.

Incandescent units of similar design but of four different manufacturers were installed. They all have a Holophane refracting glass bowl with an alzak reflector above forming a dust light fixture. The glassware projects the light in a useful path along the road with little or none wasted in the fields.

Also there was installed a mile of sodium vapour lighting. This lamp emits a soft yellow light. As the light source is a tube of glowing gas some 10 inches long and over 2 inches in diameter the intrinsic brilliancy is much lower than with the incandescent lamp of the same candle power. This tube is enclosed in a 3 wall vacuum flask and is held in a horizontal position. The reflectors which direct the light are of alzak. As the power factor of this unit is normally less than 50 per cent, a capacitor installed in each unit saved enough in power costs to pay for itself in two years.

*Night view of lighting on either side.*



*Construction crew erecting 18-ft. mastarm by means of special extension ladder truck.*

The experimental section at Sheridan consisted of a row of incandescent units on each side of one lane where there was a 30 foot dividing boulevard with switches conveniently arranged so that demonstrations could be made of the lighting on the right side of the lane, on the left side, or in a staggered arrangement. It was found that the right or the left layouts were both good, but the latter a little better for the driver who kept to the right of the road due to reflecting rays coming across as well as along the pavement.

The Department has now decided that where a road with a 30 foot dividing boulevard is to be lighted single poles will be erected in the centre of the boulevard spaced 200 feet apart. Two 18 foot mastarms will be installed, one on each side of the pole and all wires will be underground. This will avoid any damage to existing or new trees and the minimum number of poles will be in keeping with the scenic beauty of the road.

As to whether future lighting will be incandescent or sodium, and if the former whether 500 watt or smaller depends on the results of experiments now being made.

### TRAFFIC SIGNALS

It is not many years ago that traffic signal lights came into use for the control of traffic at busy intersections in the larger cities.

More recently traffic signals have been used at main intersections on important highways.

A signal installation consists of two main parts—the signal head, and the control system or dispatcher, together with necessary conductors.

The signal head consists of a metal housing with usually three faces or lenses; a red for stop, an amber for warning, and a green for go.

Behind each lens is a lamp usually of 60 watts, set in a reflector.

Various traffic conditions require different control systems. Where there is heavy traffic both vehicle and pedestrian in both roads at the intersection the Fixed Time System is used. The lights change in the regular sequence at predetermined intervals regardless of the traffic.

Where one is a main thoroughfare and the other a lesser road the Traffic Actuated System is often used. The lights remain in a certain position until moving traffic causes the lights to change in the proper sequence. This system is operated by passing vehicles either by the vehicle passing over a rubber covered pad buried in the pavement closing two contacts or by a magnetic detector. A vehicle passing over a magnet and coil buried in the pavement distorts the magnetic field enough to set up a current in the coil. This minute current is amplified in radio tubes and actuates the dispatcher.

Another form of traffic signal is the warning beacon, usually consisting of a flashing amber light either mounted on a pedestal or suspended above the road.

### SIGNS

On busy roads direction and warning signs must be easily understood both day and night. At night a simple warning sign such as a curved arrow for a curve, etc., may be readily seen and understood if outlined with reflector buttons. A direction sign with several words must be more easily read at night due to the time required to read the message. For this purpose signs are being used in which the words are painted on a white glass background with several small lamps in the box holding the glass.

The main uses of electricity on the highway have been outlined but there are many others now in use which will become of greater importance in the next few years. Pedestrian underpasses will have to be lighted; traffic counts will be made with the "electric-eye", subways at points where natural drainage is difficult will use electric sump-pumps; railway crossings will be protected with automatic electrically operated barriers. These are just a few of the future large applications.

# The Distribution Engineer and Utility Management

By Lewis Payne, President Eastern Shore Public Service Company, Salisbury, Md.

ULTIMATE objectives of management are (a) rendering adequate service economically, (b) making a profit for the stockholders, (c) maintenance of good public relations. These three objectives are so interrelated that each can be considered only in relation to the others. Good public relations, for instance, depends on adequate and economical service, and certainly profit is questionable if either good public relations or adequate, economical service is not to be had. Rendering adequate service economically, however, is dependent in the larger measure on the ability and work of the distribution engineer.

Before considering some of our present distribution problems it would be apropos to outline the qualifications of a distribution engineer:

A. He must be familiar with standards of materials and construction used for new work as well as rebuilding. He must be thoroughly familiar with all problems and economical methods of both operation and maintenance and know safety standards.

B. He must have knowledge of methods used in standard as well as special practices.

C. He must be thoroughly capable of computing line and system losses—resultant demands from diversified loads, etc.

D. He must be familiar with protective and control apparatus so as to apply such apparatus to his distribution system economically and to insure safe and continuous service.

E. He must be systematic in developing and maintaining maps and records of the distribution system.

F. He must by all means be temperamentally equipped to cooperate with others in order that the functions of the utility may operate both smoothly and economically.

These constitute the qualifications of a distribution engineer.

The specific work of a distribution engineer may be outlined as follows, and in this outline I shall endeavor to embody the principal problems that offer the greatest concern to the executive. There are five major categories.

### A. VERSATILITY, ADAPTABILITY, INGENUITY

In problems of designing and the resultant supervision of the construction of distribution systems, he must be able to adapt his ideas most economically and advantageously to fit the district to be served—good service and economical operation must result. A few years ago it was common practice to expect almost any well-designed and constructed distribution system to be good for at least a ten-year development period. The engineer is in-

deed good who has any such vision to-day.

He has the same old problems in determining load centers, proper selection of both primary and secondary voltage, consideration of whether the system is to be three or four wire, wye or delta, etc., recognizing that higher voltage permits the use of smaller wire, but these ideas were more or less commonplace when money was cheap. No longer does this condition exist, so Mr. Engineer must really get down to engineering. These same principles must yet be carried out, but mainly with what materials he may have on hand, and a step-by-step balance must be worked out progressively for each development or change in an existing system.

From an executive's viewpoint each dollar now invested or to be invested must earn from the beginning a greater return than was formerly expected. How? That is now the engineer's problem. However, as a reminder, the lower voltages can sometimes be doubled—2,300 to 4,600 volts, delta system can be wyed, existing system capacity may be frequently increased by the installation of pole type capacitors. Step regulators may be more advantageously used even in cascade. Problems in new design may involve such questions as cable vs. overhead wires, number and location of substations, and in rural lines the question of pole spacing in both rolling and flat country is not to be overlooked.

It is the writer's opinion that an individual line should be designed, and not just built to "Standard Specifications." In certain terrains it may be necessary to consider different types of line before the most economical can be determined—cut-and-try method, so to speak. Certainly in any overhead distribution line, whether urban or rural, there will be some poles and structures that will carry heavier loads than others; naturally, the reverse of this statement is just as true; so why, when economy is at stake, should an engineer be content to use all poles of a given classification just because an old specification calls for it? This may be the easy way, but is it the right way? I do not believe so.

If greater economy is to be had new ideas must be developed. We hear a great deal of system planning, load forecasting, the development of primary and secondary networks; all have their place and should be fully considered, but only in relation to its direct application to the area to be served. Ingenuity is one of the characteristics that determines the qualifications of an individual; therefore, as I have previously said, new ideas must and will be developed for further economy.

### B. New Uses For Prevailing Materials

It is the specific work of the distribution engineer to work out new applications for existing construction materials and methods of economical installations. On a property not so far from us a 6,900-volt overloaded system was recently stepped up for 22,000-volt operation. No new insulation was available—only an accumulation of pin-type insulators that had previously been removed from a 55-kv. line. These were carefully tested and all that were good for 22-kv. operation were saved and used on this line. They

may look slightly heavy and even funny to the operating staff, but the money saved looks pretty good to the executive. Another property by changing its former plan of handling meters on customers' premises avoided purchasing any new meters during the past eight months—a saving of several thousand dollars—this also looks good to the executive.

### C. Alert to Losses, Wastes, Savings

The specific work of the distribution engineer makes it necessary for him to make constant and even continuous tests to insure adequate service to his company's customers. Frequently very little concern is given either to the installation of a new transformer or to the replacement of a damaged one. Several hundred dollars is usually involved. Transformers are not cheap, nor is the equipment to protect them, but a ground rod is—costs about $1.50, I believe. How many of you require the value of this ground connection to be actually checked in every installation or change of a transformer? It is not expensive to do it and I can think of no greater saving than by minimizing our transformer losses during the lightning season, yet it has grown to be a habit to install a single ground rod for the transformer, regardless of either the nature of the soil or the value of the equipment to be protected.

In the design of a distribution system we place a great deal of importance on the anticipated losses; check after check is made. After it is in service should it not be just as important to check these losses systematically, to locate and isolate any rat holes, that they may be promptly plugged? I know of one case where a check was made on a small distribution system and one polyphase meter was found operating on the slow element; apparently it had been working as hard as any good soldier could with one side completely paralyzed since 1933. Constant and regular checks—voltage, power factor, watthour meters should be a religious requirement of every alert engineer. More and more attention is and should be given to the unaccounted-for energy. Peculiarities of individual systems partly explain a spread of from 10 to 30 per cent of the energy pumped into the distribution system which does not appear in revenue-producing kilowatt-hours.

Highly scientific operating technique of the power system manipulates individual generation efficiencies and system links so that losses from scheduling units are kept to a fraction of a per cent. But the alarming thing happens when these economies are then squandered in the far-flung distribution system. Naturally it should be the first concern of the distribution engineer to locate all of the components of loss and eradicate their causes as promptly as possible. He has many avenues in which to work; primary and secondary losses, transformer and regulator losses, meter losses as well as meter errors, errors both in reading and the result of improper connection and calibration; unauthorized diversion, and a number of other familiar channels.

The total investment in central station systems in the United States is

more than twelve billion dollars. This is divided approximately as follows: Thirty-eight per cent in distribution, 32 per cent in transmission system, 30 per cent in generating stations. In the past ten years expenditures for additions to distribution systems have increased much more rapidly than expenditures for either generating or transmission systems. For this reason the executive again looks to the distribution engineer for new methods and additional ways to overcome the unreasonable losses and insure the greatest return on the lowest investment in distribution work.

D. CO-OPERATION WITH LOAD BUILDERS

It is the specific work of the distribution engineer to co-operate with the new-business department in securing new customers as well as retaining old ones. Hydraulic brakes of an improved type have been put on the utilities' ability to build and spend without now giving full consideration and regard to the soundness and stability of the load to be served. The net result is that we now have some lines and some entire sections of our distribution system that will not permit a further loading, yet other sections are able to supply additional loads economically. Therefore, the thought of selective selling or selective loading should be a co-ordinated duty of the distribution engineer and the commercial or merchandising manager.

Certainly an added return from an existing investment will be more appealing to any executive than a request for new money for either new extensions or for revamping an existing feeder. Selective selling must be based on a prior investigation and study of the distribution system in question. With this information in hand, however, it is entirely possible and practical to select a type of equipment or appliance that will more nearly fill in with the load-building plans. Each area or possibly each feeder, however, offers a study within itself. Ranges may be permitted in the area on Front Street; however, lack of capacity on Back Street limits the load-building activities to off-peak application only.

Within the past few years air conditioning has entered the distribution field and has brought with it many perplexing problems. We now have a new device which promises to be so popular that at every crossroad store we may find a familiar sign advertising "Frozen Vegetables for Sale." With the ever-increasing popularity of this product and with the ability of the commercial refrigerator redesigned to handle properly the frozen foods we may expect an increased sale for the equivalent of small refrigerators. This load will likely be an annual one rather than the seasonal load of air conditioning.

As a further reminder the home ventilating system which operates at night only will also offer you an off-peak load in addition to the water heater, which may prove beneficial in filling the summer nocturnal valleys at least. Again, selective loading depends directly on customers' analysis; opinions even frequently supported by individual transformer load tests are misleading unless these tests are made over a sufficiently long period of time to determine definitely the load factor

of the group of customers supplied. However, in both transformer loading as well as cable loading the thermal factor should be taken into consideration. A peculiar load or a peculiar location of a transformer may limit its loading. Under normal conditions of service, however, the average distribution transformer supplying a mixed commercial or residential load is selected more from the standpoint of judgment than from the standpoint of its rating. In other words, the connected load may be many times the transformer's rated capacity.

Likewise, full advantage may be taken of cable loading if the cable temperature is known prior to the time of peak load that parallel circuits may be provided for or added ventilation or cooling provided for the cable in question. In other words, if the characteristics of a cable circuit are known, it is possible to realize even an increase in capacity when each cable loading and ventilation may be controlled separately.

### Management Highly Dependent on Competency of Distribution Engineer

While it may be both practical and economical to select a No. 2 secondary main for the most economical loading for from 25 to 100 kv-a. per thousand feet of line, the economy in the loading of this copper certainly does not vary directly with the extreme loads that may be imposed upon it. However, the smart distribution engineer usually will avoid being caught with secondary mains too small. The cost of changing them is great, and a better plan is to balance the value of the copper in place with the kilowatt-hours lost capitalized at system cost against the value of a moderate size transformer with its inherent losses capitalized, taking into consideration, of course, the junk value in each case as a credit. In most cases the balance is in favour of copper.

The present situation, as drastic and as objectionable and as disturbing as it is to many of us, has placed the distribution engineer in a position that he is absolutely drawn closer to the executives of his company than ever before. They are, in fact, more dependent on his judgment, on his ability and on his execution, in my opinion, than at any time in the history of our business. The successful engineer, however, to meet the new requirements and to be of practical value to his executive, his company and himself, must be able to develop more fully a characteristic that seems to be lacking in the make-up of many good engineers, and that is commercial adaptability.

Certainly the time is now here when a broader and brighter opportunity surrounds the distribution engineer than at any time during my experience in utility work. Executives are looking for producers. By selecting a distribution engineer having the qualifications I have tried to outline above, and by giving him the necessary co-operation in carrying out the functions as modestly outlined, the executive of a utility may be sure that, as far as the distribution system is concerned, he will be able to render adequate service economically, which, in turn, will result in profit to the stockholders and insure him of a satisfied public.—*Electrical World.*

# Report on Controlling Water Heater Loads

THE following letter which is self-explanatory was read to the Association of Municipal Electrical Utilities at its convention at Bigwin Inn, Muskoka, on July 6, 1938.

June 27, 1938.

Mr. S. R. A. Clement,
Secretary, Association of Municipal Electrical Utilities,
620 University Ave.,
Toronto, Ontario.

Dear Sir:—

At a meeting of the Convention held last Winter at the Royal York Hotel, a resolution was passed following a discussion on a paper which was presented by Mr. W. B. Buchanan in reference to control of domestic loads which read as follows:

Moved and seconded—

"That the Hydro-Electric Power Commission of Ontario be requested to make a report on the economics of controlling loads as to the operation of flat rate water heaters."

After obtaining such data as are available and studying the economics of this subject, the following report has been prepared:

At the present time two general systems are commercially available, the pilot-wire and the carrier-wave, which have been proven satisfactory in practice and which can be classed well within the economical limits of cost for this class of service.

While an economic analysis should be based on the kilowatts controllable at peak it is much more convenient to obtain data on a basis of capital cost per customer and it is the practice to submit data in this form.

A *Pilot-wire System* requires control equipment of low cost but the cost of the pilot-wire varies widely with load density of customers served, the type of district and other factors not involved in a carrier-wave system. Any study of such a system to be valid would involve an intelligent survey covering these points. The control-relays available are quite low in price but of good construction and durable.

A *Carrier-wave System* requires a greater capital outlay for generating equipment for an initial installation but the cost of the carrier-wave medium practically approaches the vanishing point. Distance-attenuation of the carrier-wave and absorption of the energy by other parts of the network are factors dictating the capacity of the control equipment in this case and these are subject to engineering calculations. Thus an initial survey of a system for this purpose would involve factors quite different to those required in planning a pilot-wire system.

Two systems are being offered locally using carrier-wave, substantially different in engineeering design but equally effective for controlling water heater loads. One

system uses a method of excitation adapted more particularly to radial feeders and segregates by such a means of sectionalizing. The other is perhaps better adapted to cases where loops predominate or cannot be avoided and a means of making a number of selections is provided.

relay, a fractional part of the cost of the generating equipment is also chargeable thereto. This disadvantage may be offset by the cost per customer of the pilot and control wires. Average costs per customer under certain assumed conditions are as follows:

| | | | | |
|---|---|---|---|---|
| Number of customers | 500 | 1,000 | 2,000 | 5,000 |
| Capital cost per customer | $20.40 | $16.60 | $15.00 | $14.00 |

This does not include possible savings which would result from serving more than one customer from one relay.

### COSTS—PILOT-WIRE SYSTEM

Average costs for such a system have been submitted indicating—

| | |
|---|---|
| Average cost per customer for cities | $15.00 |
| Average cost per customer for towns | 18.00 |
| Average cost per customer for villages | 20.00 |

on a basis of an average of 1.5 customers per relay. This computation is based on the fact that in many cases more than one customer's load can be controlled through one relay. More favorable conditions, however, have resulted in costs as low as $12.50 per customer.

### COSTS—CARRIER-WAVE

In general the costs of generating and control equipment which may range from $2,500 to $5,000 must be distributed according to the number of units under control. When this cost per customer becomes comparable with the cost per customer of installing pilot and control wires, less the difference in cost of the relays the system becomes competitive in first cost. For example, suppose a carrier-wave relay costs six dollars more per customer than a pilot-wire

The figures given make no allowance for intangible or other non-assessable factors and serve mainly to indicate that the capital cost of any of these systems can be sufficiently low as to make a very attractive proposition from the standpoint of improvement of load-factor with the inherent economies which would result. Specific claims stating return or saving of capital cost in from 10 to 12 months can be heavily discounted and a liberal margin still provided.

The above information is of a very general nature and the economic advantage of one system over another is not evident until specific circumstances of a case in question are thoroughly studied to determine the effect of some of the factors that go to make up the cost. It is therefore evident that a thorough study of each specific case where control is desired must be made before a conclusion is reached in the type of equipment to install.

Yours truly,

(Sgd.) R. T. JEFFERY,
Chief Municipal Engineer.

# THIRTIETH ANNUAL REPORT ISSUED

Copies of the Thirtieth Annual Report of the Commission, which is for the year 1937, have now been distributed to the co-operating urban municipalities, to townships served by rural power districts, and to "Hydro" utilities. Copies have also been sent to public libraries, boards of trade and chambers of commerce, and to the press throughout the larger urban centres of Ontario. Applications for additional copies of the Report should be made to—

**The Acting Secretary and Controller**
**The Hydro-Electric Power Commission of Ontario**
**620 University Avenue**
**Toronto, Ontario**

Back numbers of the Report are still available for all years except 1914. Many municipal utilities which joined the Hydro partnership in more recent years probably lack a complete file of the earlier Reports. The Commission believes it would be advantageous for all local utilities to have as complete a set as possible, and is prepared to supply, without charge, missing back numbers. The Commission suggests that where possible a set of the Annual Reports should be bound by the local utilities for permanent reference. Application for back numbers of the Report should be made as above, stating the volumes now on file.

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THE
# BULLETIN

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## W. R. Robertson

WILLIAM ROBERT ROBERTSON formerly General Superintendent of the Railway Department of The Hydro-Electric Power Commission of Ontario, died at Toronto on Saturday, August 20, 1938 in his 64th year.

Mr. Robertson was born in Hamilton, Ontario, and received his education in Hamilton and the State of Michigan schools. After several years

## CONTENTS

**Vol. XXV No. 8**

**August, 1938**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

with the steam railway industry he became associated with the Port Dalhousie, St. Catharines and Thorold Electric Railway. Starting as a motorman, he rose to the office of superintendent of the railway at the time its name was changed to the Niagara, St. Catharines and Toronto Railway.

In 1920 he was appointed General Superintendent of the Railway Department of The Hydro-Electric Power Commission of Ontario. While holding this position he was in charge of the Toronto and York Radial, The Sandwich, Windsor and Amherstburg Radial, The Peterborough Street Railway, The Guelph Street Railway, The Hamilton Street Railway and The Windsor, Essex and Lake Shore Railway. Retiring from the Commission in 1934 he was associated with the Canadian Pacific Railway for one year on the staff of the President's office. Since 1936 he has carried on a consulting practice on transportation matters with headquarters in Toronto and actively connected with Martin Transport Limited. He was on the board of directors of The Canadian Electric Railway Association, having served as President in 1926.

Mr. Robertson was active in many patriotic movements during the great war and afterward, and served as Chairman of the Soldiers' Aid. His work won for him the affections of thousands of soldiers. He was also keenly interested in sports, being a former President of the Niagara District Baseball and Hockey Association and later President of the Sunnyside Girls' Softball Association in Toronto. He was also a member of the Canadian Henley.

His quiet, kindly, sympathetic manner won him many friends on the Commission's staff and more especially endeared him to those who were directly associated with him.

Surviving him are his widow and one son, also one brother and one sister.

## Correction

In the article "Applied Science from the Viewpoint of an Electrical Engineer" in the July number, the sentence beginning at the top of the second column on page 243 should read "Energy loss and power factor measurements have been used but as it can be shown . . . ."

# The Use of Electrical Appliances Continues to Grow in Ontario

## Results of Surveys of Number of Appliances in Use in Hydro Municipalities and Rural Power Districts

By G. J. Mickler, B.A.Sc., Sales Department, H.E.P.C. of Ontario

SUBMITTED herewith are tables showing the results of surveys which have been made in Hydro municipalities and in Hydro rural power districts showing the number of electrical appliances estimated to be in use by urban and rural consumers at the end of 1937 as follows:

Table No. 1—Estimated number of major electrical appliances in use among domestic consumers at the end of 1937 in urban municipalities.

Table No. 2—Comparison of saturation of major electrical appliances in use by domestic consumers in urban municipalities at the end of 1937 in each system.

Table No. 3—Estimated number of major electrical appliances in use among hamlet consumers in rural power districts at the end of 1937.

Table No. 4—Estimated number of major electrical appliances in use among farm rural consumers at the end of 1937.

Table No. 5—Comparison of appliances in use in homes of urban and rural consumers at the end of 1937.

As in former years a survey has been made of the estimated number of appliances in use in all Hydro municipalities wherever possible. In some cases all consumers were canvassed and an actual count taken. In others, where previous surveys had been made in such a manner, estimates were prepared of the increases since such a survey was made, and in other cases estimates were made based upon the knowledge of the management of the municipality of actual

TABLE No. 1
TABLE SHOWING ESTIMATED NUMBER OF MAJOR ELECTRICAL APPLIANCES IN USE AMONG DOMESTIC CONSUMERS AT END OF 1937 IN URBAN MUNICIPALITIES

| Appliances | Number | Saturation Per Cent |
|---|---|---|
| ELECTRIC | | |
| Ranges | 141,581 | 28.6 |
| Hot Plates | 83,521 | 16.9 |
| Washers | 224,992 | 45.5 |
| Vacuum Cleaners | 151,448 | 30.6 |
| Water Heaters (Flat Rate) | 47,151 | 9.5 |
| Water Heaters (Metered) | 44,745 | 9.1 |
| Grates | 36,289 | 7.3 |
| Air Heaters | 146,313 | 29.6 |
| Ironing Machines | 11,315 | 2.3 |
| Irons | 469,045 | 94.9 |
| Refrigerators | 76,974 | 15.6 |
| Toasters | 282,294 | 57.1 |
| Grills | 52,868 | 10.7 |
| Furnace Blowers and Oil Burners | 23,371 | 4.7 |
| Air Conditioners | 2,373 | .5 |
| Radios | 356,761 | 72.2 |
| Number of Consumers | 494,315 | |

TABLE No. 2

TABLE SHOWING COMPARISON OF SATURATION OF MAJOR ELECTRICAL APPLIANCES IN USE BY DOMESTIC CONSUMERS IN URBAN MUNICIPALITIES AT END OF 1937 IN EACH SYSTEM

| APPLIANCES | All Systems | Niagara System | Georgian Bay System | Eastern System | Thunder Bay System |
|---|---|---|---|---|---|
| ELECTRIC | % | % | % | % | % |
| Ranges | 28.6 | 28.4 | 18.2 | 31.7 | 46.3 |
| Hot Plates | 16.9 | 14.6 | 30.9 | 19.0 | 56.6 |
| Washers | 45.5 | 47.7 | 42.6 | 33.4 | 56.9 |
| Vacuum Cleaners | 30.6 | 33.1 | 16.9 | 20.8 | 40.0 |
| Water Heaters (Flat Rate) | 9.5 | 9.5 | 4.8 | 13.1 | 18.9 |
| Water Heaters (Metered) | 9.1 | 8.0 | 5.1 | 19.6 | 15.2 |
| Grates | 7.3 | 8.3 | 1.4 | 4.4 | 6.6 |
| Air Heaters (Portable) | 29.6 | 31.1 | 17.7 | 25.4 | 35.1 |
| Ironing Machines | 2.3 | 2.5 | 1.2 | 1.5 | 2.3 |
| Irons | 94.9 | 95.5 | 88.6 | 91.5 | 104.5 |
| Refrigerators | 15.6 | 17.1 | 10.9 | 9.8 | 8.1 |
| Toasters | 57.1 | 55.9 | 58.5 | 60.8 | 69.7 |
| Grills | 10.7 | 8.1 | 9.3 | 19.8 | 45.7 |
| Furnace Blowers and Oil Burners | 4.7 | 5.2 | 3.2 | 3.4 | 1.8 |
| Air Conditioners | .5 | .5 | .2 | .5 | 1.3 |
| Radios | 72.2 | 72.4 | 68.6 | 70.4 | 83.9 |

conditions, and all of these estimates have been compiled in such a way as to produce as nearly as possible a record of the number of appliances calculated to be in use among Hydro consumers in Ontario.

In the case of rural power districts and hamlets operated by the Commission, a more accurate record is kept of the appliances in use, so that the figures presented are fairly reliable.

If the figures in Table No. 1 are compared with those of last year it will be found that in almost every case there is a very substantial increase in the number of appliances in use and in the percentage saturation, indicating that the efforts which have been put forward by the Commission in promoting the use of heavier appliances is being reflected not only in the use of these particular devices but in other appliances as well. Electric range saturation went up from 27.66 to 28.6 per cent, washing machines from 43.42 to 45.5 per cent, flat rate water heaters from 7.94 to 9.5 per cent, metered water heaters from 8.36 to 9.1 per cent, refrigerators from 14.29 to 15.6 per cent, and other appliances show corresponding increases.

It is interesting to note the differences between the saturation points of various appliances in different parts of the province and it would be interesting to study the cause of these differences. In some systems the rates are higher than others; then again, the habits of the people in different parts of the province vary. It is true too that in some systems the consumers are more con-

## TABLE No. 3

### Table Showing Estimated Number of Major Electrical Appliances in Use Among Hamlet Consumers in Rural Power Districts at End of 1937

| | All Systems | | Niagara System | | Georgian Bay System | | Eastern System | |
|---|---|---|---|---|---|---|---|---|
| | No. of Appliances | Percent. of Saturation | No. of Appliances | Percent. of Saturation | No. of Appliances | Percent. of Saturation | No. of Appliances | Percent. of Saturation |
| **In The Barn** | | | | | | | | |
| **Electric** | | | | | | | | |
| Motor | 1,707 | 3.85 | 1,287 | 4.48 | 47 | .76 | 373 | 3.92 |
| Pump | 551 | 1.24 | 449 | 1.56 | 20 | .32 | 82 | .86 |
| Grain Grinder | 11 | .03 | 11 | .04 | ..... | ..... | ..... | ..... |
| Milking Machine | 6 | .01 | 1 | ..... | 5 | .08 | ..... | ..... |
| Milk Cooler | 2 | ..... | 2 | ..... | ..... | ..... | ..... | ..... |
| Cream Separator | 19 | .05 | 12 | .04 | 7 | .11 | ..... | ..... |
| Churn | 8 | .02 | 4 | .01 | ..... | ..... | 4 | .04 |
| Incubator | 49 | .11 | 45 | .15 | ..... | ..... | 4 | .04 |
| Brooder | 23 | .05 | 19 | .06 | ..... | ..... | 4 | .04 |
| Hot Bed | 10 | .02 | 10 | .03 | ..... | ..... | ..... | ..... |
| Water Heater, F.R. | 6 | .01 | 1 | ..... | 5 | .08 | ..... | ..... |
| Water Heater, Met. | 1 | ..... | 1 | ..... | ..... | ..... | ..... | ..... |
| Air Compressor | 114 | .26 | 98 | .34 | ..... | ..... | 16 | .17 |
| Battery Charger | 126 | .28 | 81 | .28 | 10 | .16 | 35 | .36 |
| Miscellaneous | 116 | .26 | 111 | .38 | 5 | .08 | ..... | ..... |
| **In The Home** | | | | | | | | |
| **Electric** | | | | | | | | |
| Range | 4,992 | 11.26 | 3,630 | 12.64 | 339 | 5.54 | 1,023 | 10.75 |
| Hot Plate | 9,600 | 21.65 | 5,274 | 18.37 | 1,567 | 25.61 | 2,759 | 28.99 |
| Washer | 18,599 | 41.94 | 12,830 | 44.69 | 2,021 | 33.03 | 3,784 | 39.76 |
| Vacuum Cleaner | 5,365 | 12.10 | 3,880 | 13.52 | 415 | 6.78 | 1,070 | 11.24 |
| Water Heater, F.R. | 993 | 2.24 | 950 | 3.31 | 27 | .44 | 16 | .17 |
| Water Heater, Met. | 781 | 1.76 | 474 | 1.65 | 56 | .91 | 251 | 2.64 |
| Grate | 340 | .77 | 206 | .72 | 50 | .81 | 84 | .88 |
| Portable Air Heater | 3,379 | 7.62 | 2,063 | 7.18 | 335 | 5.47 | 981 | 10.31 |
| Ironer | 402 | .91 | 264 | .92 | 33 | .54 | 105 | 1.10 |
| Hand Iron | 30,142 | 67.98 | 20,002 | 69.68 | 3,787 | 61.89 | 6,353 | 66.75 |
| Refrigerator | 4,177 | 9.42 | 3,116 | 10.85 | 317 | 5.18 | 744 | 7.82 |
| Toaster | 20,642 | 46.55 | 13,370 | 46.58 | 2,526 | 41.28 | 4,746 | 49.87 |
| Radio | 28,237 | 63.68 | 18,224 | 63.49 | 3,672 | 60.01 | 6,341 | 66.63 |
| Furnace Blower | 678 | 1.53 | 505 | 1.76 | 28 | .45 | 145 | 1.52 |
| Pump | 4,781 | 10.78 | 3,405 | 11.86 | 464 | 7.58 | 912 | 9.58 |
| Sewing Machine | 151 | .34 | 144 | .50 | 7 | .11 | ..... | ..... |
| Miscellaneous | 1,220 | 2.75 | 962 | 3.35 | 38 | .62 | 220 | 2.31 |

centrated than in others as in the Thunder Bay system, but perhaps the biggest reason for the differences in appliance saturation is that in some parts of the province there is much greater sales effort put forward for the sale of electrical appliances than in others.

Hamlet consumers are consumers living in small hamlets and small villages operated by the Commission directly and they are in a sense urban customers. It is interesting to study the relative use of appliances by this class of consumer as compared with city users. In some cases the use of

TABLE No. 4

TABLE SHOWING ESTIMATED NUMBER OF MAJOR ELECTRICAL APPLIANCES IN USE AMONG FARM RURAL CONSUMERS AT THE END OF 1937

| | ALL SYSTEMS | | NIAGARA SYSTEM | | GEORGIAN BAY SYSTEM | | EASTERN SYSTEM | |
|---|---|---|---|---|---|---|---|---|
| | No. of Appliances | Percent. of Saturation | No. of Appliances | Percent. of Saturation | No. of Appliances | Percent. of Saturation | No. of Appliances | Percent. of Saturation |
| IN THE BARN | | | | | | | | |
| ELECTRIC | | | | | | | | |
| Motor | 6,462 | 16.97 | 4,698 | 16.33 | 658 | 20.25 | 1,106 | 18.23 |
| Pump | 4,939 | 12.97 | 4,004 | 13.92 | 347 | 10.68 | 588 | 9.69 |
| Grain Grinder | 2,087 | 5.48 | 1,622 | 5.64 | 328 | 10.09 | 137 | 2.26 |
| Milking Machine | 986 | 2.59 | 653 | 2.27 | 57 | 1.75 | 276 | 4.55 |
| Milk Cooler | 553 | 1.45 | 452 | 1.57 | 27 | .83 | 74 | 1.22 |
| Cream Separator | 2,356 | 6.19 | 1,653 | 5.75 | 154 | 4.74 | 549 | 9.05 |
| Churn | 367 | .96 | 283 | .98 | 31 | .95 | 53 | .87 |
| Incubator | 419 | 1.10 | 325 | 1.13 | 31 | .95 | 63 | 1.04 |
| Brooder | 322 | .84 | 242 | .84 | 19 | .58 | 61 | 1.01 |
| Hot Bed | 39 | .10 | 37 | .13 | ..... | ..... | 2 | .03 |
| Water Heater, F.R. | 55 | .14 | 45 | .15 | 8 | .24 | 2 | .03 |
| Water Heater, Met. | 47 | .12 | 25 | .08 | 14 | .43 | 8 | .13 |
| Air Compressor | 66 | .17 | 66 | .23 | ..... | ..... | ..... | ..... |
| Battery Charger | 55 | .14 | 39 | .13 | 16 | .49 | ..... | ..... |
| Miscellaneous | 332 | .87 | 172 | .60 | 139 | 4.27 | 21 | .34 |
| IN THE HOME | | | | | | | | |
| ELECTRIC | | | | | | | | |
| Range | 6,462 | 16.97 | 5,728 | 19.91 | 285 | 8.77 | 449 | 7.40 |
| Hot Plate | 8,300 | 21.80 | 6,151 | 21.39 | 839 | 25.82 | 1,310 | 21.60 |
| Washer | 21,909 | 57.54 | 17,712 | 61.58 | 1,592 | 49.00 | 2,605 | 42.95 |
| Vacuum Cleaner | 4,859 | 12.76 | 4,145 | 14.41 | 208 | 6.40 | 506 | 8.34 |
| Water Heater, F.R. | 1,281 | 3.36 | 1,211 | 4.21 | 35 | 1.08 | 35 | .57 |
| Water Heater, Met. | 637 | 1.67 | 500 | 1.74 | 29 | .89 | 108 | 1.78 |
| Grate | 288 | .75 | 242 | .84 | 21 | .64 | 25 | .41 |
| Portable Air Heater | 3,748 | 9.84 | 2,994 | 10.41 | 160 | 4.92 | 594 | 9.79 |
| Ironer | 459 | 1.21 | 389 | 1.35 | 21 | .64 | 49 | .81 |
| Hand Iron | 28,672 | 75.31 | 22,766 | 79.16 | 2,193 | 67.49 | 3,713 | 61.22 |
| Refrigerator | 3,786 | 9.94 | 3,123 | 10.86 | 334 | 10.28 | 329 | 5.42 |
| Toaster | 19,941 | 52.37 | 15,838 | 55.07 | 1,488 | 45.79 | 2,615 | 43.11 |
| Radio | 26,090 | 68.52 | 20,439 | 71.07 | 2,013 | 61.95 | 3,638 | 59.98 |
| Furnace Blower | 540 | 1.42 | 429 | 1.49 | 25 | .77 | 86 | 1.41 |
| Pump | 5,603 | 14.72 | 4,455 | 15.49 | 505 | 15.54 | 643 | 10.60 |
| Sewing Machine | 73 | .19 | 71 | .24 | 0 | ..... | 2 | .03 |
| Miscellaneous | 945 | 2.48 | 818 | 2.84 | 19 | .58 | 108 | 1.78 |

appliances is if anything greater than in other urban centres and in other cases the use is less. The reason for this is a variation in rates, habits of the people and their buying power, as it is recognized that people living in smaller communities have less money to spend on modern equipment in the home than city dwellers. Here too, the sales effort exerted by manufacturers and dealers is much less than in cities and towns.

If we will compare the figures in Table No. 4 with those of 1936 we will find a radical difference not only in the number of appliances in use

TABLE No. 5
COMPARISON OF APPLIANCES IN USE IN HOMES OF URBAN AND RURAL CONSUMERS

| | R.P.D. HAMLET | | R.P.D. FARM | | URBAN | |
|---|---|---|---|---|---|---|
| | No. of Appliances | % of Saturation | No. of Appliances | % of Saturation | No. of Appliances | % of Saturation |
| ELECTRIC | | | | | | |
| Range | 4,992 | 11.26 | 6,462 | 16.97 | 141,581 | 28.6 |
| Hot Plate | 9,600 | 21.65 | 8,300 | 21.80 | 83,521 | 16.9 |
| Washers | 18,599 | 41.94 | 21,909 | 57.54 | 224,992 | 45.5 |
| Vacuum Cleaner | 5,365 | 12.10 | 4,859 | 12.76 | 151,448 | 30.6 |
| Water Heater (Flat Rate) | 993 | 2.24 | 1,281 | 3.36 | 47,151 | 9.5 |
| Water Heater (Metered) | 781 | 1.76 | 637 | 1.67 | 44,745 | 9.1 |
| Grate | 340 | .77 | 288 | .75 | 36,289 | 7.3 |
| Air Heater | 3,379 | 7.62 | 3,748 | 9.84 | 146,313 | 29.6 |
| Ironers | 402 | .91 | 459 | 1.21 | 11,315 | 2.3 |
| Irons | 30,142 | 67.98 | 28,672 | 75.31 | 469,045 | 94.9 |
| Refrigerators | 4,177 | 9.42 | 3,786 | 9.94 | 76,974 | 15.6 |
| Toasters | 20,642 | 46.55 | 19,941 | 52.37 | 282,294 | 57.1 |
| Radios | 28,237 | 63.68 | 26,090 | 68.52 | 356,761 | 72.2 |
| Furnace Blower | 678 | 1.53 | 540 | 1.42 | 23,371 | 4.7 |

but in the saturation percentages. This is due to the fact that we added in 1937 so many new consumers who apparently had not purchased electrical appliances to the same extent as consumers who were on the lines before 1937, and our survey extended further afield this year than last year. There is, however, indicated a very substantial increase in the number of electrical appliances reported in use. These figures all show the tremendous possibilities that still exist for the sales of electrical equipment among farm consumers and they serve as an indication also of the possibilities there are among new consumers who are added each year. That is to say, in the case of electric motors, if 17 per cent of our existing consumers are using electric motors it is safe to say that there is a market for 170 new motors for every 1,000 new consumers added to our lines.

The same thing applies to all appliances and when one considers that in 1937 we added 8,600 new farm consumers and that we expect to approach that figure this year, one can realize what a tremendous market there is for electrical equipment in Ontario.

Then too, there is the possibility of increasing the average saturation by equipping existing consumers with more electrical equipment. All that is required is an intensive canvassing by manufacturers and dealers to cultivate this field.

It is interesting to note how the rural consumers take to the use of electrical equipment in comparison with their city cousins. From Table No. 5 one can see that the farm housewife who has to perform many heavy duties in connection with the operation of the farm is gradually taking advantage of labor-saving devices available to lighten her burdens.

It is also interesting to note the high saturation of washing machines and radios. Of our farm consumers, 57.54 per cent have washing machines and 68.52 per cent electric radios. The saturation of other appliances are equally impressive.

All of the above tables indicate that while there is a fairly high saturation of electrical equipment in the homes of Ontario there is still room for improvement. It is estimated that the average home in Ontario is not more than 20 per cent saturated with electrical appliances; that is to say, comparing the use of electricity of an average home with the average use made by domestic consumers in Ontario, there is a possibility of increasing the average consumption through electrical appliances five times.

We must take into account the fact that Natural Gas prevents the widespread use of electric ranges. Then too, Municipal Gas Plants have their effect and the absence of waterworks systems curtails the use of water heaters in every municipality and rural power district to a large extent, but taking these circumstances into consideration we are still some distance from the saturation point for many electrical appliances in this province.

# Rate Reductions, 1938

THE report of the Hydro-Electric Power Commission of Ontario for the year ending October 31, 1937, shows that the financial results of the operation of the co-operative systems were very satisfactory to all municipalities supplied from them.

NIAGARA SYSTEM

The total revenue received by the Commission from all municipalities of the Niagara System amounted to $16,611,805.95. The total cost of power for the year, as provided to be paid by them under the Power Commission Act, amounted to $16,437,366.33. In the adjustment of the surplus arising from the operation of the Commission, $314,095.71 was returned to certain municipalities and other cost customers and $139,656.09 was collected from certain municipalities and other cost customers.

The Commission has reviewed and analyzed the financial situation in connection with the distribution of power within these municipalities. From the result of this analysis, which was based upon the 1937 revenue and from the 1937 operating costs, the Commission recommended that the rates to be charged to domestic, commercial and power consumers be reduced in a large number of cases.

The total estimated saving to consumers served by this system by means of the reduction in rates is as follows:

| | |
|---|---|
| Flat Rate Water Heaters | $ 15,356.48 |
| Domestic lighting service | 78,073.69 |
| Commercial lighting service | 18,629.79 |
| Power service, etc. | 25,326.09 |
| Street lighting | 4,106.00 |
| Total | $141,492.05 |

In addition to the above-mentioned rate reduction, refunds to consumers

in 35 municipalities were also authorized. The total estimated refund to these consumers will amount to $89,200.98.

The analysis shows that certain refunds should be made to the municipalities themselves in connection with the supply of power for municipal purposes such as waterworks, street railways and street lighting. These refunds will amount to $62,785.12. The consumers in the municipalities served by the Niagara System will, therefore, benefit by $293,478.15. Of this amount $89,200.98 will be refunded to them by a deduction from their monthly bill and $141,492.05 will be deducted from their monthly bill by means of rate reductions. The refund to the municipalities of $62,785.12 will benefit the taxpayers in general.

The operating reports of the municipalities on the Niagara System show that the municipal electric utilities, so served, obtained a total revenue for the year 1937 of $27,655,224.96. The total expenses for these utilities for the same year amounted to $26,657,092.88 after providing for the cost of power, operation and fixed charges. The net surplus obtaining for that year amounted to $998,132.08.

*    *    *    *

## GEORGIAN BAY SYSTEM

The total revenue received by the Commission from all municipalities of the Georgian Bay System amounted to $854,341.18. The total cost of power for the year, as provided to be paid by them under the Power Commission Act, amounted to $819,784.78. In the adjustment of the surplus arising from the operation of the Commission $36,036.45 was returned to certain municipalities and $1,480.05 was collected from certain municipalities.

A careful study has been made by the Commission's engineers of conditions pertaining to the supply of power to each municipality, and in making these studies to determine the rates to be charged during the year 1938 the engineers have kept in mind the fact that it will shortly be necessary for the Commission to absorb major expenditures in regard to additional supplies of power for the system and to increase the voltage of the transmission lines and stations connecting the generating plants of the Severn river with lines in the western part of the system, in order that additional power may be transmitted from present and future sources of supply to meet the growing demands of the system.

This expenditure, when made, will temporarily increase the cost of power to all municipalities on the system, until sufficient load has been obtained to absorb the charges on these expenditures.

From the results of the analysis of the financial situation in connection with the distribution of power within these municipalities, which was based upon the 1937 revenue and operating costs, the Commission recommended that the rates to be charged to domestic, commercial and power consumers be reduced in a large number of cases. In the case of one municipality a slight increase in rates was necessary.

The total estimated saving to consumers served by this system by

means of the reduction in rates is as follows:

| | |
|---|---|
| Flat Rate Water Heaters | $ 337.75 |
| Domestic lighting service | 12,223.24 |
| Commercial lighting service | 6,244.73 |
| Power service | 3,336.00 |
| Street lighting service | 1,337.00 |
| Total | $ 23,478.72 |

In addition to the above-mentioned rate reduction, refunds to consumers in 19 municipalities were also authorized. The total estimated refund to these consumers will amount to $37,450.00.

The analysis shows that certain refunds should be made to the municipalities themselves in connection with the supply of power for municipal purposes such as waterworks and street lighting. These refunds will amount to $6,846.96. The consumers in the municipalities served by the Georgian Bay System will, therefore, benefit by $67,775.68. Of this amount $37,450.00 will be refunded to them by a deduction from their monthly bill; $23,478.72 will be deducted from their monthly bill by means of rate reductions. The refund to the municipalities of $6,846.96 will benefit the taxpayers in general.

The operating reports of the municipalities on the Georgian Bay System show that the municipal electric utilities, so served, obtained a total revenue for the year 1937 of $1,214,887.41. The total expenses for these utilities for the same year amounted to $1,166,131.28, after providing for the cost of power, operation and fixed charges. The net surplus obtaining for that year amounted to $48,756.13.

* * * *

### EASTERN ONTARIO SYSTEM

The total revenue received by the Commission from all municipalities of the Eastern Ontario System amounted to $2,129,551.49. The total cost of power for the year, as provided to be paid by them under the Power Commission Act, amounted to $2,008,951.89. The surplus of $120,717.96 arising from the operation of the Commission was returned to all municipalities except one, in which case a charge of $118.37 was made.

From the financial situation in connection with the distribution of power within these municipalities, and the results of an analysis, based upon the 1937 revenue and operating costs, the Commission recommended that the rates to be charged to domestic, commercial and power consumers be reduced in a large number of cases. The total estimated saving to consumers served by this system by means of the reduction in rates is as follows:

| | |
|---|---|
| Flat Rate Water Heaters | $ 10,998.55 |
| Domestic lighting service | 12,654.14 |
| Commercial lighting service | 4,296.43 |
| Power service | 6,520.00 |
| Street lighting service | 2,919.00 |
| Total | $ 37,388.12 |

In addition to the above-mentioned rate reduction, refunds to consumers in 12 municipalities were also authorized. The total estimated refund to these consumers will amount to $40,212.73.

The analysis shows that certain refunds should be made to the municipalities themselves in connection with the supply of power for municipal purposes such as waterworks and street lighting. These refunds will amount to $27,368.86. The consumers

in the municipalities served by the Eastern Ontario System will, therefore, benefit by $104,969.71. Of this amount $40,212.73 will be refunded to them by a deduction from their monthly bill; $37,388.12 will be deducted from their monthly bill by means of rate reductions. The refund to the municipalities of $27,368.86 will benefit the taxpayers in general.

The operating reports of the municipalities on the Eastern Ontario System show that the municipal electric utilities, so served, obtained a total revenue for the year 1937 of $3,565,496.87. The total expenses for these utilities for the same year amounted to $3,275,047.33, after providing for the cost of power, operation and fixed charges. The net surplus obtaining for that year amounted to $290,449.54.

* * * *

### THUNDER BAY SYSTEM

The total revenue received by the Commission from all municipalities of the Thunder Bay System amounted to $1,044,675.71. The total cost of power for the year, as provided to be paid by them under the Power Commission Act, amounted to $1,038,812.88. In the adjustment of the surplus arising from the operation of the Commmission, $7,165.43 was returned to two cost municipalities on this System, and $1,302.60 charged to one municipality.

The Commission has also reviewed and analyzed the financial situation in connection with the distribution of power within these municipalities. From the result of this analysis, based upon the 1937 revenue and operating costs, the Commission has recommended that the rates to be charged to domestic and commercial consumers be reduced in Fort William, Nipigon Township and Geraldton.

The total estimated saving to consumers served by this system by means of the reduction in rates is as follows:

| | |
|---|---|
| Domestic lighting service | $ 5,800.00 |
| Commercial lighting service | 5,700.00 |
| Total | $ 11,500.00 |

In addition to the above-mentioned rate reduction, refunds to consumers in Port Arthur were also authorized. The total estimated refund to these consumers will amount to $74,000.00.

The analysis shows that certain refunds should be made to the municipalities themselves in connection with the supply of power for municipal purposes such as waterworks and street lighting. These refunds will be made in Fort William and Nipigon Township and the total amount to be refunded will amount to $1,353.66. The consumers in the municipalities served by the Thunder Bay System will, therefore, benefit by $86,853.66. Of this amount $74,000.00 will be refunded to them by a deduction from their monthly bill; $11,500.00 will be deducted from their monthly bill by means of rate reductions. The refund to the municipalities of $1,353.66 will benefit the communities at large.

The operating reports of the municipalities on the Thunder Bay System show that the municipal electric utilities, so served, obtained a total revenue for the year 1937 of $1,315,931.40. The total expenses for these utilities for the same year amounted to $1,251,096.24, after providing for the cost of power, operation and fixed charges. The net surplus obtaining for that year amounted to $64,835.16.

# Progress in Accounting

By Austin H. Carr, C. A., Editor, The Canadian Chartered Accountant, Toronto

*(Presented at the Accounting Session of the Association of Municipal Electrical Utilities at Bigwin Inn, Muskoka, July 6, 1938.)*

AT most conventions which I have attended the programme is such that between 10 a.m. and 5 p.m. there comes a heavy load of addresses. This has always been somewhat of a strain; but in the brief period that I have come in contact with your association I have learned a valuable lesson. A breakfast meeting of this sort shows how wide awake this body of electrical engineers is in its endeavour to distribute the load. My current hope is that you may receive what I have to say with the same resignation as you accept a variety of breakfast foods, the daily reports of scientific progress, the overnight news of our governments, the ups and downs of the financial markets, and the record of our baseball team in the National series.

It has been duly hinted to me, first, that at this early hour you do not want any technical matters in accounting dealt with but prefer to hear about some of the influences affecting the progress of accounting up to the present; and second, that I should tell it in as short a time as possible. So gentlemen, I do not want to interfere with the digestion of your first meal of today, and I shall promise to cease speaking well within my allotted time.

The sciences of medicine and jurisprudence have been in the forefront for many, many centuries. Accounting as we have it today is of comparatively recent development, but its origins go far back into antiquity. You doubtless already know something about the early history of accounting; I shall not, then, go into the details. Suffice it to say that every method, or device, or system for recording what has taken place at any particular time arose through the necessity of keeping a record thereof. The electric meter and the water meter placed in my basement have come because of that need. The history and the records of ancient civilizations indicate that for centuries barter and traffic had existed between nations and peoples; it is not difficult for us to realize that barter even in its primitive form necessitated some system of accounts.

It was in the days of the great trade activity of the Italian City States five or six hundred years ago that accounting first attained the dignity of a science. With their control of the Mediterranean and the commerce of the then known world, such cities as Genoa, Florence and Venice had their counting houses staffed with men who not only kept with accuracy the records of business transactions, but who, in the spirit of inquiry of that day, were on the

alert to discover a simpler and more exact system of recording these transactions. A number of text-books on commercial subjects were published in Florence during the 14th century when this city was a leader in banking operations throughout Europe. While the first known treatise on the subject of double-entry bookkeeping was published in the 15th century in Venice, discoveries now prove beyond doubt that the double-entry ledger was in use in Genoa as early as the year 1340. Without such an advanced system of keeping accounts for recording the results of their vast commercial transactions, it is acknowledged that the banks of Florence could not have conducted their extensive operations of the following century.

### Accounting in Great Britain

It is to Great Britain, however, that we must turn for the record of the greatest advances made in accountancy theory and practice, and it is to the accountants of Scotland and England that we are indebted for the system of accounting on this continent. The progress in those countries, then, should have deep interest for us. Yet I shall not enter into details. Let us only note that the earliest system of accounts was the English Exchequer established about eight centuries ago. The system was based on the Domesday Book which was a record of all taxable estates in the kingdom and from which the treasurer's Great Roll or Pipe Roll was written up. To each sheriff was entrusted the collection of the taxes in his district. He made his returns twice yearly, receiving at the first accounting half a tally stick having notches representing the amounts turned in to the treasurer, the latter official retaining the other half. At the final accounting the sheriff turned in his tally as evidence of payment made. It was then compared with the one in the treasurer's keeping to see that no alterations had been attempted.

The people of Scotland to this day are noted for their expert knowledge of accounting. In the early days they had devised a system of recording the receipts and disbursements of the Royal revenues and instituted a regular audit of the accounts. We are told that the use of the tally was never adopted in Scotland and that, when in the process of Anglicization of the administrative system of that country a cargo of birch fagots arrived in Edinburgh for use as tallies in the Exchequer, the citizens ridiculed the idea and made a bonfire of the cargo.

The devising of a good system of accounts for the finances of the realm had important influences then just as it has today. Inefficient methods of collection had heretofore resulted in only a fraction of the revenue ever reaching the taxing authority. Necessity was as usual the mother of invention, and the improved system of accounting served to remove temptation from those charged with the collection of the royal revenues. Besides, when the officials of the Exchequer came into touch with the episcopal clerks throughout the realm, a knowledge concerning account keeping was thereby diffused. It might be expect-

ed, then, that it would be only a matter of time before a proper mode of keeping accounts was adopted by corporations and individuals for their own private affairs.

### The Trading Companies

A great impetus to the developmentment of the science of accounting followed upon England's interest in commercial and in colonial expansion—two closely connected movements. For hundreds of years Englishmen had traded abroad, but it was during the 16th and 17th centuries that many great trading companies were formed. For instance, in the year 1600 the East India Company received its charter and in 1670 the Hudson's Bay Company. The need for accurate account keeping followed on the operations of these joint-stock companies. Like many others of these trading companies, the East India Company in the first decade of its history obtained subscriptions for each voyage to the East. Part of this money was invested in merchandise, part was used to fit out the expedition and part was retained in the form of cash. After the voyage was over the proceeds thereof, and sometimes part of the merchandise itself, were divided among the adventurers in proportion to their subscriptions. Four years ago through the kindness of the Governor of the Hudson's Bay Company I received the page of the stock ledger recording the subscription of £370 of Prince Rupert to the capital stock of the company in 1667, three years before the company received its charter. The page is an interesting record and was reproduced in the May, 1934, issue of *The Canadian Chartered Accountant.*

### Some Influences Towards Progress

Let me survey briefly a few of the factors and events which have contributed in a considerable degree to the progress of accounting in more recent times.

*Urge to Account Keeping*—If you should discuss the public practice of accountancy with some of the older members of our profession you would learn that a large part of the work of the public accountant forty, fifty and sixty years ago had to do with insolvent estates. The main reason for that condition was that the number of people who kept books and who made up a balance sheet were certainly in the minority. Only when things began to look bad for the trader was an expert accountant brought in to ascertain how matters stood. Today bankruptcy has a relatively small place in the practice of the professional accountant. Firms are now more concerned with methods for ascertaining the condition of their business and keeping it in health than in attending its obsequies. Today the accountant is engaged in feeling its pulse and reporting periodically upon its condition to the increasing number of persons interested in it. That new attitude had a revolutionary effect on the keeping of accounts, and it encouraged the development of an accountting system best adapted to the particular business or industry.

But there are many other causes for this change. One is the rise of the limited liability company, or the joint stock company as it is com-

monly known in Great Britain. Enterprises which because of their magnitude could not be financed by an individual or a few partners sought the resources of others for their ventures and thus called to their aid the funds of thousands of small investors. These innumerable so-called partners were naturally interested in knowing the result of their investment; the urgency of account keeping and the publication of financial statements is consequently apparent.

Another reason is that because of the size of modern businesses either by natural growth or amalgamation, and because of the necessity for providing means to keep company officials informed from day to day on matters which it is impossible for them to watch in detail, an effective system of accounting record has had to be in use.

A third reason is the introduction of the State as a party interested in the correct ascertainment of taxable profits, and the interest of the taxpayer in being assured that he is not taxed on profits which he has not made. I think I am safe in saying that above every other cause this has accelerated the introduction of accurate account keeping and has encouraged the reaching of definite conclusions on the method of dealing with almost every type of business transaction. The evidence is clear that marked progress has come in the field of accounting theory because of the differentiation that had to be made between income and capital profits and losses.

As an illustration of the problems arising daily which demand the consideration and application of accounting theories, let us think of what constitutes the dividend of a metal mining company in its relation to the income tax. The mine is what is known as a wasting asset. At the end of its useful life no asset will remain and the investment of the shareholders in this particular mine will therefore be nil. Consequently in every dividend paid by the company, the shareholder receives a portion of his capital returned to him in addition to the income on his investment. In the administration of the income tax, due consideration is given to that theory with the result that a percentage of mining dividends is exempt from tax.

I may also add that the numerous firms of every kind and description in Canada, that before 1917 (the year in which the *Income War Tax Act* was first passed) had been apathetic or neglectful in installing a proper system of accounting for their business, soon found that with the introduction of this Act their days of grace in this respect were cut short. The keeping of accounts by trading and other concerns became an obligation.

Another reason that will also occur to you is the necessity of producing some authentic figures in support of applications for the granting or the continuance of bank accommodation. It must be apparent to all that every one of these four circumstances has been a contributing factor to the evolution of more effective methods of account keeping.

### Adoption of Fiscal Period

There is another influence that has had a wide reaching effect on the

progress of accounting. I refer to the adoption of the annual fiscal period.

The use of a set period of time for the reckoning of profits has given rise to all sorts of problems which demand definite treatment in the accounts, and as an illustration of one of these I direct your attention to the depreciation of capital assets.

Because of its derivation from the Latin word meaning "price," the term depreciation in accounting terminology is frequently misunderstood. If one will visualize the commercial venture of English colonial days, to which we have just referred, a simple illustration is afforded of its application. For such a venture there was a stock of salable goods; supplies and necessaries for the voyage had to be provided, and a sailing craft purchased. With the merchandise sold and the voyage over, the excess provisions, if any, were disposed of, the craft was sold, and the net proceeds of the venture distributed. The difference between the cost of the craft and its selling price as scrap represented depreciation, and was just as much a part of the cost of the venture as were the merchandise and the provisions.

The cause of many mistaken ideas about depreciation can undoubtedly be laid at the door of the present-day system of fiscal periods. Though the trading transactions just mentioned may have extended over one, two or more years, no division of time was considered necessary in the determination of profits. And it is safe to say that because of the modest extent of their dealings, the individual trader and the partnership of years ago seldom concerned themselves with an annual "check-up" of their business. The advent of the modern complex industrial system, however, brought a change. The introduction of a fixed accounting period followed as a natural consequence of the rise and rapid growth of the incorporated company. With the increase in numbers of small investors during the past century and the widespread holding of industrial securities, the call of shareholders for periodic dividends not only made account keeping important as we already noted, but also made necessary some regular time for "stock-taking," and this encouraged the use of a definite period of trading, or what we have come to call the fiscal year.

The term depreciation as employed commercially is associated with the fixed or capital assets of a business. Today a concern makes expenditures in one fiscal period with the definite purpose of producing profits in future periods. How should such outlays be dealt with in its accounts? That is the central problem of financial accounting; it has forced upon industry a study of the proper allocation of these expenditures to the periods concerned, and a scientific treatment of the depreciation of the fixed or working assets.

As the function of fixed assets is to produce income, you are aware of course that such assets are to be recorded on the books at cost. No useful purpose would be served by attempting to determine their value or selling price, inasmuch as any valuation at best is only a guess, one valuer's estimate being as good as an-

other's though both may be widely different.

You as engineers appreciate that another problem closely associated with depreciation, and which looms up in a threatening manner as far as accounting is concerned, is the possibility of obsolescence or the premature termination of the useful life of a fixed asset. It is obvious that the loss occasioned thereby is properly a charge against income over the years of the useful life which has come to an end. But the plant or equipment has become obsolete; the accounts for previous years are closed. What is to be done about the asset figure yet to be written off? It is the emergence of such problems that compels accountants to adopt some consistent treatment of them in accounting.

*Inventories* — Another problem which arises through the adoption of an annual fiscal period is the figure to be set on the merchant's stock of goods unsold at the end of the year. The valuation placed on the inventory has so great an effect on the determination of profits that consistency of treatment is an evident necessity and is, in fact, a requirement of the taxing authorities.

If all commercial transactions could be completed and wound up within a fiscal period the term "inventory" would become an obsolete one so far as stock in trade is concerned; but such a situation cannot be imagined. Even if a stationary price level were always in effect, many of the difficulties connected with annual stock-taking would vanish. But we have our business cycles—a boom period with its rising prices, to be followed by a period of depression and deflation, in which are wiped out the fictitious profits that arose through a gradual rise in the valuation placed on inventories during the former period.

"In industrial practice today," a leading chartered accountant stated recently, "the statement of inventories at cost or market, whichever is lower, is, I believe, by far the most generally accepted rule. Its merit lies obviously not in its logic but in its conservatism; and even though its acceptability for balance sheet purposes may be conceded, questions may fairly be raised as to how the difference between cost and market should be dealt with for the purposes of the income account. This is, I think, a case in which further study and development of practice is clearly called for and in which it would be most unwise to crystallize too hastily the existing practice through uniform regulations. In the interests of candor, I should perhaps add that there is considerable variety in the way in which the principle of 'cost or market whichever is lower' is actually applied, and that the degree of uniformity now attained is, therefore, by no means as great as those unfamiliar with the actual workings of the system might suppose."

### Accounting Machines

As one aspect in the progress of the mechanics of accounting, let me before I close say a word on the use of accounting machines. The old order of things is continually changing, and the laborious methods of keeping accounting records by hand have given way to mechanical appli-

ances. The despatch with which modern business is transacted, the importance of recording costs quickly and accurately in industrial plants, the need for statistical records to afford information to executive heads—these and many other causes which occur to you have accelerated the adoption of mechanical bookkeeping and accounting machines, and these appliances at present have reached a high standard of perfection and utility. That change, however, has to do with the mechanics of accounting, not with the principles and theories of accounting to which I have directed your attention very briefly this morning.

# Domestic Load Development in the City of Winnipeg

**By J. W. Sanger, Chief Engineer, City of Winnipeg Hydro-Electric System**

*(Address delivered at the convention of the Ontario Municipal Electric Association and the Association of Municipal Electrical Utilities at Bigwin Inn, Muskoka, July 5, 1938.)*

FOR the year 1937 the average consumption of electrical energy for the 40,761 domestic customers of the City of Winnipeg Hydro-Electric System was 4,765 kw-hr. Because this average consumption is greater than that which has been experienced in other parts of Canada, a considerable amount of interest has been aroused in the methods by which the City of Winnipeg has created such a large sale of electricity for domestic purposes.

The intention in this address is to give a general historical outline of the efforts which have been made to develop Winnipeg's domestic load during the past twenty-five years and to supplement this information by appropriate comments and statistical data in the hope that they may be of some value to those engaged in electrical utility operations.

At the outset it might be well to discuss briefly, the relative prodigality of Winnipeg's domestic customers in the use of electrical energy, particularly with respect to the economic soundness, or otherwise, of the policies which have produced these results. Some comments should be made, therefore, on the financial stability of the utility and also on the rates charged for domestic service as compared with those for commercial service.

The financial position of the utility may be gauged by the following statements:—

The City of Winnipeg Hydro-Electric System made a net profit of $212,000 in the year 1937 after providing for all capital debt charges and reserves.

The utility pays to the City of Winnipeg an annual amount equival-

ent to the taxes which a privately-owned electrical utility would pay to the City.

All renewals are charged against operating income in the year the expenses are incurred.

Within the next ten years the accumulation in the sinking fund, together with the portion of the funded debt which will then have been retired, will amount to over 70 per cent of the present capital debt of $27,000,000.

The utility is now making a special contribution to the City of $150,000 per annum for general municipal expenditures.

In respect to the comparative rates for domestic and commercial customers, the following tabulation shows the average revenue per kilowatt-hour for all classes of business where the total consumption exceeded five million kilowatt-hours per annum.

| | Cents per kw-hr. |
|---|---|
| Domestic Lighting | 2.360 |
| Domestic Heating & Cooking | .914 |
| Domestic Water Heaters | .389 |
| Commercial Lighting | 2.265 |
| Commercial Heating & Cooking | .966 |
| Commercial Water Heating | .267 |
| Commercial Power | .924 |
| Street Lighting | .546 |
| Municipal Building Lighting | .775 |
| Water Works Power | .625 |
| Large Electric Boilers | .1 |
| Average all Customers | .638 |
| Average all Customers less Electric Boilers | .868 |
| Average all Domestic Customers | .827 |

It will be noted that with the exception of domestic and commercial lighting, the average revenue per kilowatt-hour was less than one cent.

### Competitive Operation

Prior to the year 1911, the City of Winnipeg obtained its electrical service from a private company which not only operated a utility retailing electricity direct to the consumer, but in addition operated a gas utility and transportation system in the city and the surrounding municipalities. A dispute between the City and the Company about the rates charged for electrical service resulted eventually in the City building its own power plant on the Winnipeg river and going into active competition with the Company for the light and power business.

The Company and the City have now been in active competition for the past twenty-seven years and one of the most important points to be kept in mind when discussing the Winnipeg situation is the stimulating effect of competitive operation. Not only has there been competition between the two electrical utilities, but also between the publicly-owned electrical utility and the privately-owned gas utility. While it must be admitted that there is a certain amount of economic loss in competitive operation due to the duplication of effort, there are many compensating factors which have turned out to be beneficial to the public and have provided a highly progressive type of service at low cost.

### Domestic Rates

The rates for domestic service in the City of Winnipeg are as follows:

(1) The lighting rate, which is a composite rate of 3-1/3c and 1c per kw-hr., the lower rate going into effect when 5 kw-hr. per 100 square feet of floor area have been consumed.

(2) The heating and cooking rate of 1c per kw-hr.

(3) The flat rate for water heaters:

| Capacity of Heater Watts | Monthly Flat Rate Gross |
|---|---|
| 500 | $1.67 |
| 750 | 2.50 |
| 1,000 | 3.33 |
| 1,500 | 4.44 |
| 2,000 | 5.55 |
| Over 2,000, per 1,000 watts | 2.22 |

Some reference should be made to the adoption of separate metering for lighting and cooking services whereas only one meter would be required if a combination rate were put into effect. On the basis of economy of operation, the two meter method cannot be defended and there is little doubt that the Winnipeg utilities will measure all domestic energy consumption on one meter in the near future, with the exception of water heating which will remain a flat rate service. It is of some interest to note that the separate metering of cooking services has permitted the accumulation of statistical information on domestic range consumption which has been used effectively in selling the advantages of the electric range over the gas range. Furthermore, this information is of paramount importance in determining the economics of range and water heater loads.

### Domestic Appliance Saturation

Comparative records of the average annual consumption of domestic customers lose much of their significance unless they are accompanied by an analysis of the purposes for which the energy is used. This is evident in the domestic records of the City of Winnipeg for the year 1937.

| Classification of Service | No. of Services | Kw-hr. Sold | Net Revenue |
|---|---|---|---|
| Domestic Lighting | 40,761 | 29,178,856 | $ 688,703.93 |
| Domestic Heating & Cooking | 26,125 | 51,768,657 | 473,291.96 |
| Domestic Water Heaters | 20,948 | 112,559,685 | 437,642.60 |
| | | 193,507,198 | $1,599,638.49 |

Of the 193,507,198 kw-hr. consumed by domestic customers, 58.1 per cent was used for water heating, 26.7 per cent for heating and cooking, and 15.2 per cent for lighting, refrigeration, radio and similar services. Water heating and cooking can be said to have consumed 85 per cent of the energy sold for domestic purposes. From these figures it will be seen that domestic load development should be expressed in terms of major appliance saturation and not in total kilowatt-hours consumed, as this method of expression indicates better the potential amount of domestic business economically available to the utility.

Fig. 1 shows the growth of electric ranges and flat rate water heaters on the City of Winnipeg Hydro-Electric System since the year 1920. For the years 1934 to 1937 separate curves are given for ranges in private houses and apartment buildings. The following are the saturation figures for the year 1937.

| | Per Cent |
|---|---|
| Ranges in private houses | 60. |
| Ranges in apartment buildings | 76.2 |
| Total domestic range saturation | 62.75 |
| Flat rate water heaters in private houses | 61.9 |
| Total domestic water heater saturation | 51.4 |

It will be observed that the total domestic water heater saturation in combined private houses and apartment buildings is considerably lower than the saturation in private houses. This is due to suites in apartment buildings having a common source of

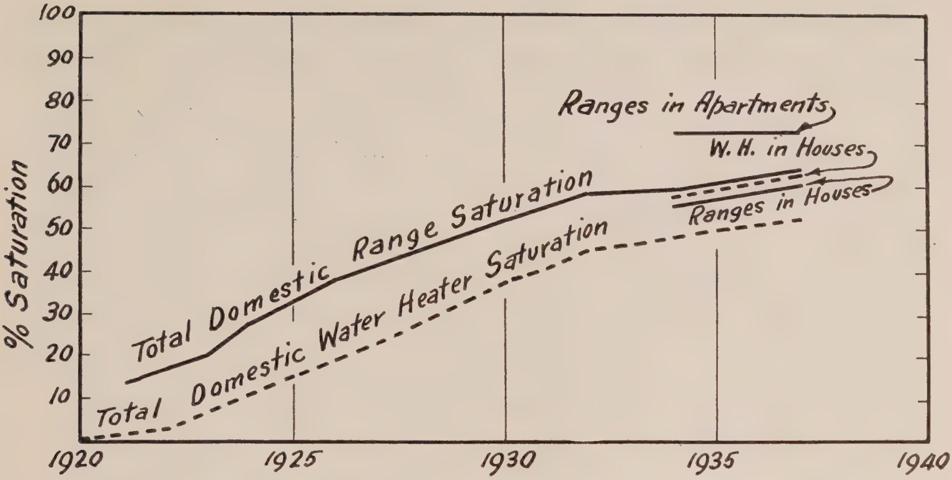



*Fig. 1—Saturation curves for domestic electric ranges and water heaters.*

hot water and for this reason the number of potential water heating services should be considered only in relation to the number of private house lighting services.

There appears to be a remarkable similarity in the shape of the range and water heating saturation curves particularly with respect to the ultimate saturation point. At the present time the opinion is held that the ultimate saturation for these two appliances will not exceed 70 per cent. There is also a similarity in the time period over which these loads have been developed and it suggests that under circumstances similar to those experienced in Winnipeg, fifteen years are required to reach a point beyond which the growth will be comparatively slow.

Due to the fact that domestic refrigerators may be installed on house lighting circuits in Winnipeg without the utility being notified, reliable information is not available on the growth of this type of load. In a recent inspection of consumers' premises it was found that the domestic refrigerator saturation in Winnipeg was 24.6 per cent and from the appliance sales record the rate at which this load is developing appears to be similar to that experienced with other major appliances.

### Sale of Appliances

Within two years from the time the City's plant first went into operation it became evident that the City would receive its greatest support from domestic customers as, in a very short period of time, most of the domestic customers had changed over from the privately-owned utility to the publicly-owned utility. In those days domestic load consisted almost entirely of lighting and unless something were done to extend the field of domestic service this type of load would not be particularly attractive. The only solution to the problem was for the City to go either directly or indirectly into the business of merchandising electrical appliances.

Private retail merchandising stores could not be expected to participate enthusiastically in load promotional activities except from the point of view of the immediate profit on the sale of appliances. From the City's point of view the profit resulting from the sale of appliances was a minor consideration as compared with the sale of energy. It was decided, therefore, that the best interests of the customer would be served by the utility going into the business of direct retail merchandising. From a modest beginning in 1913 there has now been built up a merchandise business having sales amounting to $400,000 per annum.

The first attempt at direct merchandising by the City was the sale of electric irons on an instalment plan of 75c down and 75c per month. There is no record of the number of sales made but the response was so great that sufficient encouragement was received to stimulate further merchandising activities. Although only a very humble beginning, the electric iron campaign indicated that there was a business opportunity for the sale of electrical appliances which had not been explored by electrical utilities. Other small electrical articles were soon added to the list of appliances sold and at the same time a considerable amount of advertising was started to popularize the idea of electrical cooking.

The first attempt to train electrical appliance salesmen was made in the year 1918 when the power sales and clerical staffs were given a series of lectures on salesmanship. A specialist on selling was brought in to deliver the lectures and to organize the employees into teams of salesmen. The ground was well prepared by a large amount of press advertising featuring the advantage of electrical cooking over the old method and customers were requested to send in for booklets describing the advantages of modernizing the kitchen. Return postcards were also sent out by direct mail advertising and it was from the postcards returned that the first prospect list was made up.

To spur on the salesmen, score charts were placed on the walls of the office giving the sales record of each man and each team. Commission of $5.00 was paid for each sale and for special merit a salesman was awarded a gold star together with an additional $5.00 for each five sales made. One of the advertising features at this time was the placing of cards on every Hydro pole bearing the slogan "Cook by Wire and Electricity, Half the Cost of Coal, Gas or Wood".

The results of this campaign were sufficiently successful to justify the building of special showrooms and although they were located on a thoroughfare isolated from the shopping district, they had the advantage of being adjacent to the main business office where most of the light and power bills were paid. With the building of the showrooms, the first conflict of interest took place with the electrical contractor-dealers and meetings with the trade representatives were almost a weekly occurrence. The fact that the dealers had failed to accomplish anything worthwhile after five years with the one cent cooking rate was beyond dispute, hence there

was little justification for complaint as the dealers were benefitting greatly from the large number of wiring jobs which would not have been obtained without the City's efforts in appliance merchandising.

With the advent of the showrooms, the appliance department branched out and sold almost every kind of electrical appliance; vacuum cleaners, washing machines and ranges being the most popular items. Flat rate water heating service appeared on the scene in the year 1920 and at the end of that year, 161 were in use. In four years the number had increased to 2,266 mostly of 750 watt and 1,000 watt capacity. At this period water heaters cost $13.50 and the wiring $15.00 which now would be considered an expensive job.

Early in 1924 an effort was made to increase range and water heater sales by reducing considerably the cost of the appliances and wiring. Tenders were called for on 1,000 ranges from the leading manufacturers and in the specifications tenderers were asked to ignore the list price and to supply a type of range of the same quality of construction as the standard range but using the name Hydro instead of the usual manufacturer's trade name. The lowest tenders were received from two of Canada's outstanding manufacturers at prices of $65 and $70 and as these prices were approximately $20 below the current prices for standard ranges, it permitted retail sales to be made to customers at $100 instead of the usual list price of $135. Special prices were also obtained on water heaters and the competition between the manufacturers for this business was so intense that the price dropped quickly from $5.00 to $2.00, enabling the retail sale of a water heater to the public at a price of $5.00 or $15.00 installed complete with wiring.

A double page spread in the newspapers advertised the City's offer to install a range and water heater complete with wiring for $150.00, or a range and wiring only for $135.00, two years to pay and finance charges extra. Unfortunately for the City its competitors in the utility business decided to make a more attractive offer and advertised a standard range with wiring for $135.00 with two years to pay and without finance charges. This was tantamount to a cut of $15.00 on the City's offer. The City's customers began immediately to threaten to withdraw their business unless the same terms as offered by the private company were made available to them. To meet the situation the City decided to offer free wiring which was equivalent to a reduction of $15.00 on the original price. The episode passed off satisfactorily, and approximately 1,500 Hydro ranges were sold. In this manner free wiring for ranges and water heaters was started in Winnipeg.

The intensity of competition in Winnipeg had now been raised to a high degree and it was not long before another campaign was started with the object of converting all apartment buildings from gas cooking to electric cooking. The first offer made by the City was to install ranges in apartment buidings at no expense to the owner. The tenant, however, was charged a rate of 2c per kilowatt-hour,

1c being the standard cooking rate and the other cent being supposed to take care of maintenance and carrying charges over a period of ten years. At the time the offer was made it seemed reasonably sound although no reliable information was available which could be used as a definite guide to estimate the average consumption of ranges in apartment suites. In those days the average consumption of ranges in private houses was 3,000 kilowatt-hours per annum and consequently it was thought that a low estimate for apartment suite ranges would be about 1,800 kilowatt-hours per annum.

The response to the plan was very gratifying and in a short time 2,500 gas ranges in apartment suites were replaced by electric ranges. Unfortunately the energy consumption of apartment suite ranges fell, in many cases, far below the estimate and although the plan was successful from the point of view of starting the vogue for electric cooking in all apartment buildings, it had to be abandoned and replaced by a plan in which a fixed amount for rental was charged for the range and 1c per kilowatt-hour for the energy. In this second plan 1,500 ranges were quickly installed making a total of 4,000 ranges installed in apartment buildings in a short period of time. By this time all the best apartment buildings in the city were equipped with electric ranges and since then all new apartment buildings in the city have been equipped with electric range service as a matter of course.

Concurrently with the range campaigns a successful kitchen unit campaign was started in the year 1924. The results were phenomenal and over ten thousand contracts were signed. The campaign had only got well under way when one of the large departmental stores offered the public a competitive fixture at less than one third of the price. This resulted in the cancellation of 25 per cent of the contracts but the net result was that more than ten thousand kitchen units were installed by the end of the campaign.

In order to further stimulate the water heater business a plan was offered to the public in 1932 in which water heaters were installed free for a rental charge of 10c per month. With this plan the water heater saturation in private houses has been raised to 61.9 per cent.

In 1931 the City found itself with a new six and one half million dollar power plant and a business depression getting well under way. Another range campaign was started in which the special attraction was $10.00 worth of free current and $17.00 contribution towards the cost of installing the range. This campaign was quite successful and helped to maintain domestic revenue throughout the worst period of the depression.

By 1935 the best of the new range business had been obtained and there were some signs of sales decreasing in spite of the fact that the range replacement business was now an important factor in the operations of the appliance department. To meet the situation an up-to-date retail store was established on the best business thoroughfare and a five year long-term payment plan was offered to purchas-

ers of all major electric appliances with financing charges of only 4 per cent for each year of the deferred payment period. In other words, for a one year contract 4 per cent was added to the cash price, 8 per cent for a two year contract and 20 per cent for a five year contract. This resulted in very low monthly instalments and although there were some fears that long terms would increase the levies for bad debt reserves, the records up to date show that the accounts have been very well paid. It would appear, therefore, that there is a financial soundness in long term payments provided that the monthly instalment appears to the customer to be an insignificant amount compared with the value he is receiving from the article purchased.

A change in policy has recently been made with the object of reducing the amount of money tied up in instalment sales. The plan for refrigerators and range sales is now as follows:

*Refrigerators:*

| | |
|---|---|
| Minimum down payment | $5.00 |
| Minimum monthly payments | 4.50 |

Monthly payments may be reduced below $4.50 provided the period over which the payments are made does not exceed thirty-six months.

*Ranges:*

| | |
|---|---|
| Minimum down payment | $5.00 |
| Minimum monthly payments | 3.50 |

Monthly payments may be reduced below $3.50 provided the period over which the payments are made does not exceed twenty-four months.

For the more expensive appliances the time period may be extended in excess of thirty-six months.

OBSERVATIONS ON THE SALE OF ELECTRICAL APPLIANCES

There are many things in Winnipeg which have influenced the public in the purchase of electrical home appliances and although opinions may differ as to relative values, there is little doubt that low rates for domestic service have been the most important reason. These low rates have made it possible for customers to discard their coal and gas appliances in favour of electrical appliances which can be used at a lower cost.

The next most important influence is the personal gratification in the possession and use of attractive and up-to-date home appliances which can be acquired by easy terms of payment and are well within the reach of all except those who are continuously unemployed. Here, we have the reason for the utility going into the merchandising business, as it is not to be expected that the customer will have any desire to purchase cheap electrical energy exept in so far as it will enable him to operate economically the appliances he purchases.

While discussing the cost of using electrical appliances it will be of some interest to give the combined average revenue figures in Winnipeg for the three classes of domestic service.

| | |
|---|---|
| Average annual domestic lighting revenue | $16.96 |
| Average annual range revenue | 18.41 |
| Average water heater revenue | 23.48 |
| Total | $58.85 |

This total of $58.85 can be said to be a fair representation of the annual cost of electrical service in the average home when equipped with range and water heater. The expected increase in refrigerator sales will raise

this total to $64.00 and the average monthly bill for electricity for this standard of electrical service will be $5.33.

The next point to consider is one which may be the controlling factor in the future development of domestic load in Winnipeg. How much of the family income will the customer be prepared to spend on electrical service? The answer divides naturally into two parts, the operating expense resulting from the use of the electrical appliances which have replaced some other item of household expense, and the expense resulting from the use of appliances which might be considered to have raised the customer's cost of living. In both cases the amount of electricity consumed by the customer will be intimately related to the domestic rates charged by the utility.

Of the many things which have helped to promote the sale of electrical appliances in Winnipeg, the least expected was the manner in which the retail merchants entered energetically into the business as soon as it was evident that the retail stores of the utilities had awakened the public interest and would probably keep it alive by advertising and other publicity work. Not only have the large departmental stores become very active competitors but also a variety of small merchants have reserved parts of their show window space for the display of ranges and refrigerators. Nothing has stimulated the activities of the retail merchants so much as the participation of the electrical utilities in the merchandising business and although the small merchant operates under a considerable financial handicap, he still finds enough business to make it worth while. The reason may arise from the fact that major appliance sales are dependent to a great extent on personal contact between the salesman and the customer and although the showroom may be the nucleus of the sales organization, the individual effort of the salesman in the field appears to be the most important part of the sales effort.

Retail appliance salesmen employed by the City of Winnipeg are paid on a commission basis with a small minimum salary which is virtually part of the commission paid. The earnings of the salesmen approximate 5 per cent of their gross sales and small bonuses are given for cash sales and sales in excess of an annual quota. These commissions are lower than those usually paid in the trade, the reason being that the preference of the public to purchase appliances direct from the City makes the volume of sales greater than it would be in private business.

The total advertising and publicity budget for the City of Winnipeg Hydro-Electric System was $52,000 for the year 1937. Of this amount $12,000 was charged to the merchandising department as representing advertising strictly prepared for the promotion of merchandise sales. There was recovered from manufacturers under co-operative advertising arrangements the sum of $5,000, leaving a net advertising expense of $7,000 on gross merchandise sales of $400,000 or 1.75 per cent.

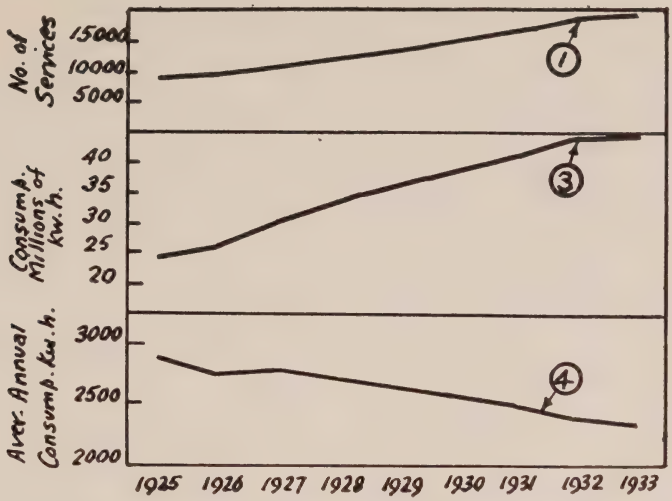



*Fig. 2—Private house service, ranges. Conditions of service:—Range and wiring supplied by customer. Rate:—1 cent per kw-hr., minimum bill 50 cents, cash discount 10 per cent.*

| Year | 1925 | 1926 | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|---|---|
| Curve 1, Average No. of services | 8,689 | 9,720 | 11,128 | 12,611 | 14,020 | 15,325 | 16,883 | 18,700 | 19,105 |
| Curve 3, Consump. million kw-hr. per yr. | 24.6 | 26.5 | 30.8 | 34.1 | 36.96 | 38.82 | 41.64 | 44.12 | 44.34 |
| Average annual consump. per service | 2,828 | 2,724 | 2,769 | 2,700 | 2,636 | 2,533 | 2,466 | 2,359 | 2,322 |
| Average No. of empties per month | 139 | 115 | 91 | 83 | 76 | 174 | 256 | 328 | 425 |
| Curve 2, Average No. occupied per month | 8,550 | 9,605 | 11,037 | 12,528 | 13,944 | 15,151 | 16,627 | 18,372 | 18,680 |
| Curve 4. Average annual consump. per occupied house | 2,875 | 2,755 | 2,792 | 2,718 | 2,651 | 2,562 | 2,504 | 2,401 | 2,373 |

Note:—Of the number of services shown there are 2.44 per cent located in apartment blocks which if rated the same as ranges on plan No. 2 would show an annual consumption of 2,344 kw-hr. per service at 2,400 kw-hr. per occupied house for year 1933.

## RANGE CONSUMPTION IN PRIVATE HOUSES

In spite of the many years of experience in Winnipeg with the development of range load, there still remain many variable factors which call for frequent check and further investigation. The two most important of these are the average energy consumption and the average power demand per range. Occasionally the most reasonable assumptions turn out to be incorrect because some important and unexpected factor has been overlooked. An outstanding example will be given when discussing the effect of water heaters on range consumption.

In the year 1934 records of range consumption in Winnipeg were compiled carefully and there appeared to be ample evidence to justify the conclusion that the average consumption per range decreases as saturation increases. This condition was expected as it seemed natural that the greatest sales resistance would come from the people who can least afford to purchase ranges and who, when they purchase them, must be as economical as possible in the use of energy.

Fig. 2 gives the consumption record of ranges installed in private houses during the period from 1925 to 1933. In this period the number of ranges increased from 8689 to 19105 and the average consumption per occupied house decreased from 2875 kilowatt-hours per annum to 2373 kilowatt-hours per annum. Since 1933 the average range consumption in private houses has dropped to 2250 kilowatt-hours per annum. At this point it should be mentioned that the consumption per range includes the energy consumed by the small appliances which may be plugged into the range circuit. The true range consumption is therefore slightly less than the amounts given but the degree to which it is less is not known.

From Curve 4 in Fig. 2 it will be seen that the decrease in average consumption over the nine year period is quite regular and does not appear to be influenced by the business depression in the years 1930 to 1933. When these records were compiled everyone agreed that the gradual decrease in the average consumption was the result of increased range saturation.

At the end of the year 1936 a discussion took place on the merits, or otherwise, of continuing to subsidize water heater installations and it was suggested that the increase in revenue from the installation of a water heater would have to be discounted considerably in cases where the customer has already an electric range because these two appliances were intimately related in their functions. In other words it was expected that the water heater might relieve the range of its duty to heat water from the cold water tap temperature of 50 deg. fahr. to 150 deg. fahr.

An investigation was made in the hope that some conclusive evidence could be obtained and although the number of customer records examined was not very large, due to the fact that each customer account tested had to conform with special requirements as to similarity in family conditions in the periods under comparison, the results were startling and quite conclusive.

First, the records of one hundred customers, all taking range and water heater service were examined for the five year period from 1932 to 1936. These were compared with the general consumption records and the results compiled and tabulated. The hundred test customers showed no indication of decreasing annual consumption over the five year period. In fact the 1936 consumption was slightly higher than the average for the five year period.

Next, thirty customers were found who had resided at the same address for two years, the first year with range service only and the second year with range and water heater service. The following results were obtained:—

| | Kw-hr. per annum |
|---|---|
| Average consumption of range service for one year before water heater installed | 3,650 |
| Average consumption of range service for one year after water heater installed | 2,360 |
| Difference | 1,290 |
| Decrease in consumption | 35% |

The decline in range consumption as shown in Curve 4, Fig. 2, can now be said to reflect the growth of water heater load and not increased range saturation.

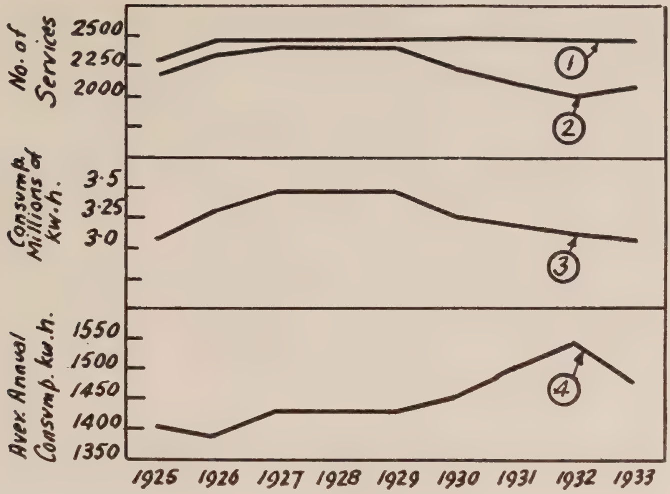



*Fig. 3—Apartment building service, plan No. 1, ranges. Conditions of service:—Range and wiring installed free. Rate:—2 cents per kw-hr., minimum bill $1.00 per month, cash discount 10 per cent, free maintenance service.*

| Year | 1925 | 1926 | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|---|---|
| Curve 1, Average No. of services | 2,291 | 2,460 | 2,470 | 2,479 | 2,486 | 2,478 | 2,472 | 2,456 | 2,455 |
| Curve 3, Consump. millions kw-hr. per yr. | 3.062 | 3.301 | 3.454 | 3.471 | 3.458 | 3.294 | 3.204 | 3.129 | 3.084 |
| Average annual consump. per service | 1,337 | 1,342 | 1,398 | 1,400 | 1,391 | 1,329 | 1,296 | 1,274 | 1,256 |
| Average No. of empties per month | 117 | 90 | 57 | 56 | 69 | 219 | 347 | 431 | 375 |
| Curve 2, Average No. occupied per month | 2,174 | 2,370 | 2,413 | 2,423 | 2,417 | 2,259 | 2,125 | 2,025 | 2,080 |
| Curve 4. Average annual consump. per occupied suite | 1,409 | 1,393 | 1,431 | 1,423 | 1,431 | 1,458 | 1,508 | 1,545 | 1,483 |

## RANGE CONSUMPTION IN APARTMENT BUILDINGS

In a previous part of this paper reference was made to the low consumption of apartment building ranges as compared with those installed in private houses. Fig. 3 gives the consumption data on a group of 2,500 ranges installed in apartment suites, covering a period of nine years when the number of occupied suites remained approximately constant. It will be noted that the consumption varied between 1,409 and 1,483 kilowatt-hours per annum and that except for the last year the trend of consumption was in an upward direction.

Two other groups of apartment building ranges, the results for which are tabulated in Figs. 4 and 5, show similar characteristics and although the conditions of service were dissimilar in all three cases, the annual consumption per range keeps close to the 1,500 kilowatt-hour mark. The charge for energy for the ranges in the Fig. 3 group was 2c per kilowatt-hour which included maintenance and carrying charges. The charge for the group of ranges in Fig. 4 was 1c for energy plus a fixed amount for carrying and maintenance charges. The ranges in Fig. 5 were supplied from the same circuit as the lighting, hence the range consumption is only an estimate and cannot be considered in any way accurate.

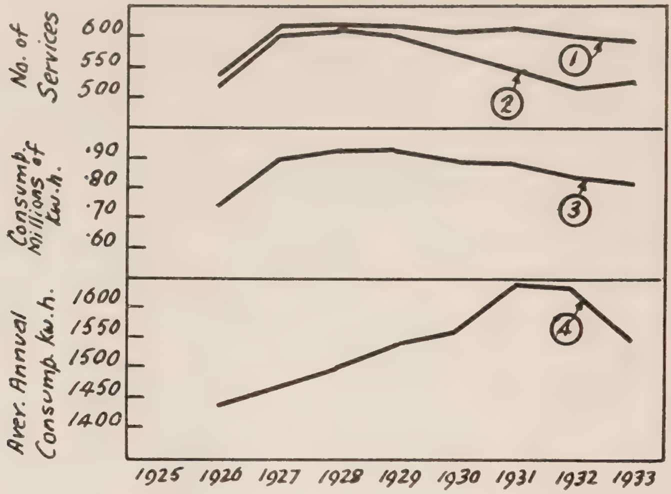



*Fig. 4—Apartment building service, plan No. 2, ranges. Conditions of service:—Ranges and wiring installed free. Rate:—1 cent per kw-hr. plus a flat rate maintenance charge, minimum bill 55 cents, cash discount 10 per cent.*

| Year | 1926 | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|---|
| Curve 1, Average No. of services | 534 | 615 | 624 | 622 | 612 | 614 | 603 | 595 |
| Curve 3, Consump. millions kw-hr. per yr. | .748 | .892 | .927 | .932 | .899 | .890 | .841 | .816 |
| Average annual consump. per service | 1,402 | 1,450 | 1,485 | 1,498 | 1,470 | 1,450 | 1,396 | 1,371 |
| Average No. of empties per month | 14 | 8 | 9 | 18 | 37 | 71 | 88 | 69 |
| Curve 2, Average No. occupied per month | 520 | 607 | 615 | 604 | 575 | 543 | 515 | 526 |
| Curve 4, Average annual consump. per occupied suite | 1,439 | 1,469 | 1,507 | 1,542 | 1,564 | 1,640 | 1,634 | 1,550 |

## RANGE DEMAND

Many conflicting opinions have been expressed on the subject of the average power demand of domestic ranges in large groups and although from time to time range demand curves have been published in technical journals, the difficulty associated with investigations of this sort makes it necessary to accept published data with a certain amount of reserve. With this in mind a special effort was made in Winnipeg in the year 1933 by which it was hoped to establish the "most probable figure" and if some assumption had to be made, a value would be found below which the average demand per range could not possibly go.

Recording instruments were installed on a group of 1031 ranges in apartment suites where the ranges and lighting were on separate circuits. The range demand curves of each separate group tested were combined in a variety of ways into mass curves which not only established the average demand per range for groups of various numbers, but also indicated clearly the trend of the demand curve.

The average demand per range in apartment suites for groups in excess of 1,000 was determined as .865 kilowatts. It was also found that groups in excess of 1,000 would make very little difference in the results. The average line loss from the apartment buildings to the 66 kv. receiving station was estimated to be 6.9 per cent, hence the average demand per range at the receiving station was determined as .93 kilowatts.

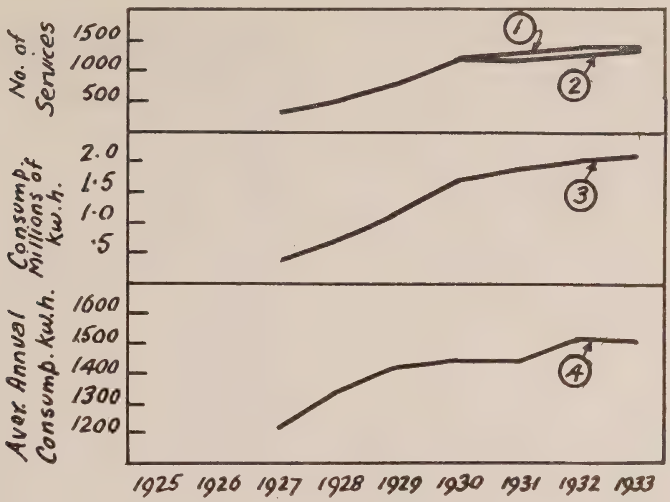



*Fig. 5—Apartment building service, plan No. 3, ranges. Conditions of service:—Range owned by the block owner, light and heat on one meter, 350 kw-hr. have been deducted from total annual consumption to arrive at net range consumption. Rate:—May 1 to Sept. 30, 1st 25 kw-hr. at 3.33 cents gross per kw-hr., excess at 1 cent gross per kw-hr.; Oct. 1 to April 30, 1st 50 kw-hr. at 3.33 cents gross per kw-hr., excess at 1 cent gross per kw-hr.; minimum bill 55 cents; cash discount 10 per cent.*

| Year | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|
| Curve 1, Average No. of services | 324 | 540 | 839 | 1,251 | 1,362 | 1,464 | 1,473 |
| Curve 3, Consump. millions kw-hr. per yr. | .395 | .735 | 1.171 | 1.745 | 1.934 | 2.064 | 2.109 |
| Average annual consump. per service | 1,219 | 1,356 | 1,394 | 1,395 | 1,421 | 1,411 | 1,432 |
| Average No. of empties per month | 0 | 0 | 19 | 42 | 68 | 111 | 77 |
| Curve 2, Average No. occupied per month | 324 | 540 | 820 | 1,209 | 1,294 | 1,353 | 1,396 |
| Curve 4, Average annual consump. per occupied suite | 1,219 | 1,356 | 1,428 | 1,444 | 1,494 | 1,525 | 1,510 |

In Winnipeg this is considered to be the minimum figure and it is assumed that the average demand per range for private houses, because of the greater energy consumption, must be somewhere in excess of one kilowatt. Several methods have been used to estimate what the excess over the apartment suite range is likely to be and the general opinion is as follows:—

| | |
|---|---|
| Average demand for ranges in private houses where water heaters are installed | 1.05 kw. |
| Average demand for ranges in private houses where water heaters are not installed | 1.2 kw. |

The figures for ranges in private houses are given for what they may be worth and it is suggested that they be accepted with reserve, only in respect to the extent they exceed the established demand of .93 kilowatts for ranges in apartment suites.

### The Effect of High Saturation on Capacity of Flat Rate Water Heaters

Experience in Winnipeg with flat rate water heating services raises a point which is of importance to those who may be contemplating entering this field of domestic business. There are two distinctly different angles from which this class of business should be approached and the one which is the more important seems to be the one which has had the least consideration.

The first angle of approach might be called the conventional one and is

simply a question of the type of equipment and the cost of service required for the maintenance of a continuous supply of hot water for the normal domestic requirements of the home. All water heating customers would like to have this type of service but unfortunately not more than 25 per cent are prepared to pay or are able to pay the cost.

The second angle of approach is one in which the quantity of water heated, or the temperature to which the water is raised, is of secondary importance as compared with the monthly bill for energy. In this case the customer requires the best hot water service that can be obtained at a cost not exceeding a certain sum each month. If water heater saturation becomes high, it is only natural that the majority of water heater customers will be of this type.

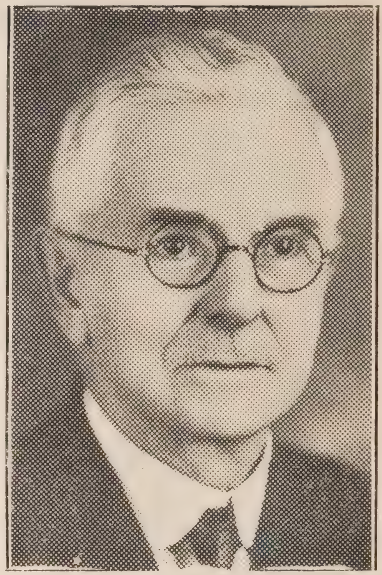
This fact is amply demonstrated by the following tabulation of the capacity rating of the flat rate water heaters installed in Winnipeg:—

| Rating | Percentage of total installed | Net monthly bills |
|---|---|---|
| 3,000 w. | less than 1% | $6.00 |
| 2,000 w. | less than 2% | 5.00 |
| 1,500 w. | less than 2% | 4.00 |
| 1,000 w. | less than 12% | 3.00 |
| 750 w. | less than 31% | 2.25 |
| 500 w. | less than 54% | 1.50 |

From these figures it would appear that a large part of the domestic water heating business in Winnipeg is controlled by a limitation of $1.50 per month.

## D. C. Davis, Aylmer

Following an illness of but a few weeks, Daniel C. Davis, secretary-treasurer of the Aylmer Public Utilities Commission since its inception, died on Wednesday, July 27, 1938.



*Daniel C. Davis*

Mr. Davis was born in Aylmer and lived there all his life. As a young man he was engaged in the dry goods business. Along with four associates he pioneered the first electric lighting plant in Aylmer, when a direct current arc lighting generator was installed in a saw and planing mill to light the streets and a few of the stores and churches. When this plant was sold to the town about 1897, he was made secretary-treasurer of the Aylmer Utilities, which position he has held ever since. In 1910 he was appointed town clerk, where he proved himself an efficient, obliging and popular official, and it is in no small way due to his good judgment and advice that Aylmer now enjoys an enviable financial position. He was also secretary of the Aylmer board of health, and in addition carried on a successful insurance business for many years.

# THE BULLETIN

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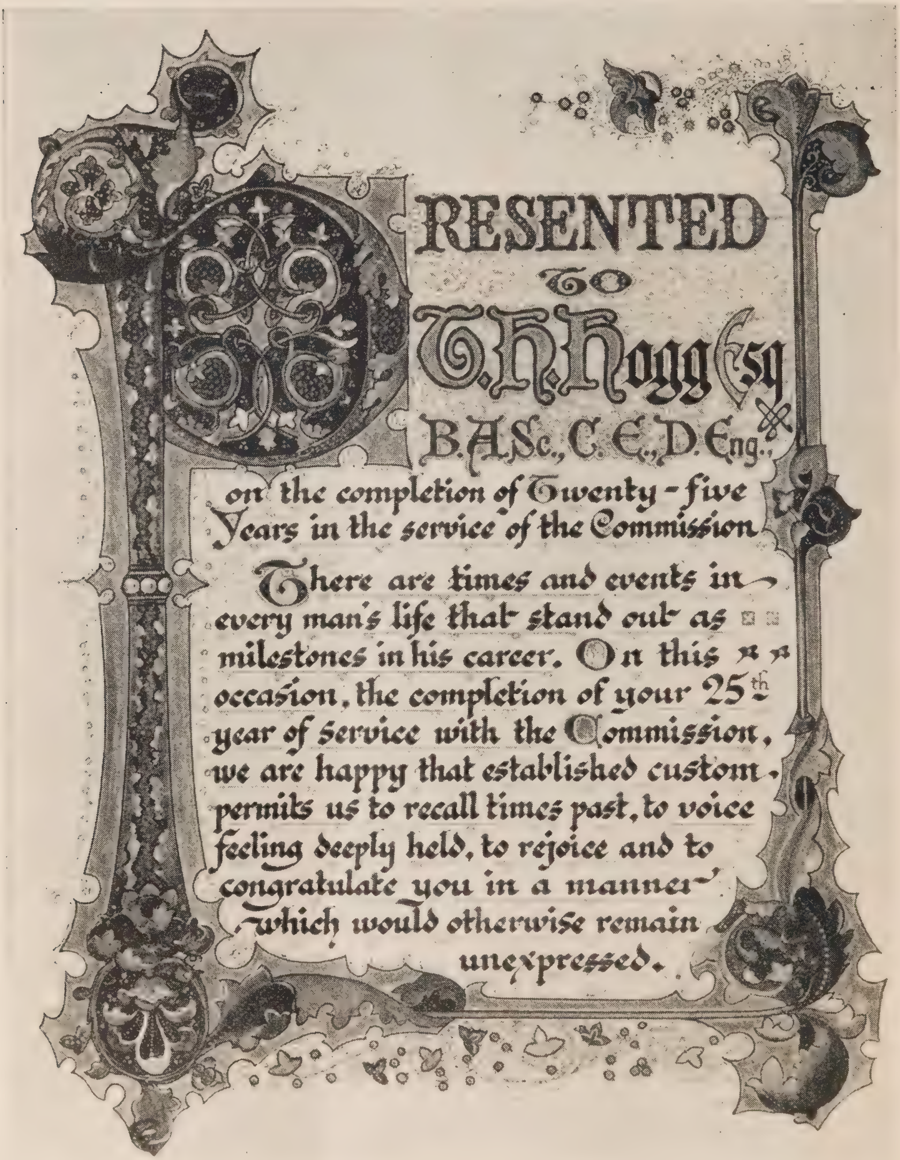
*Dr. Thomas H. Hogg*

SEPTEMBER, 1938



PRESENTED
TO
T. H. Hogg Esq
B.A.Sc., C.E., D.Eng.,
on the completion of Twenty-five
Years in the service of the Commission

There are times and events in
every man's life that stand out as
milestones in his career. On this
occasion, the completion of your 25th
year of service with the Commission,
we are happy that established custom
permits us to recall times past, to voice
feeling deeply held, to rejoice and to
congratulate you in a manner
which would otherwise remain
unexpressed.

*First page of the Address presented to Dr. Hogg by the Hydro staff. Full text of the Address is shown opposite.*

THERE are times and events in every man's life that stand out as milestones in his career. On this occasion, the completion of your 25th year of service with the Commission, we are happy that established custom permits us to recall times past, to voice feeling deeply held, to rejoice and to congratulate you in a manner which would otherwise remain unexpressed.

The occasion that calls us together is a particularly happy one since it signalizes not only a brilliant period in your career, but also an event which has crowned the achievements of that period, and has brought to all of us the liveliest satisfaction,—namely, your appointment as Chairman of The Hydro-Electric Power Commission of Ontario.

You were intimately concerned with the hydraulic design of the first plant constructed by the Commission and have taken an active part in every power development it has projected or completed since then. The earlier projects offered you an opportunity of exercising and developing talents which stood you in good stead in the solution of more difficult problems encountered in the larger and later developments. These talents have been ably exercised in supervising the necessary investigations and in directing the design of hydraulic works which rank as outstanding examples of engineering achievement. Moreover, the honours conferred upon you and the demands for your services, both in Canada and abroad, bear witness to the eminence you have attained in your vocation.

Through the years, you have revealed yourself as a man of rare gifts and lofty ideals, an understanding friend and adviser, whose kindly counsel has contributed much to the well-being of all those who have sought it.

Your dealings with your associates have been marked by fairness, tolerance, sympathy and goodfellowship. These characteristics are attested by those who have long enjoyed your friendship, and who have been privileged to work with you, and who now join in expressing the respect, goodwill and affection they bear you.

These personal qualities, combined with distinguished technical proficiency and proven administrative ability, eminently fit you for the responsibilities of the task to which you have been called. Your recent appointment to the Chairmanship of the Commission is a reward truly merited and widely acclaimed. We, who represent all grades and callings in the organization, earnestly and enthusiastically join in this acclaim. We are proud that among our number there has been found one worthy of this honour. We are gratified because it has been bestowed upon one possessing in such high degree the endowments necessary for successful direction of this enterprise.

It is our earnest hope that you will be granted health and happiness in the fulfilment of your duties, and that you will long be spared to continue in this high office. We are confident that your administration will be distinguished by notable successes, and to this end we pledge the loyalty and support of a staff united in its faith in Ontario's Hydro-Electric enterprise, and devoted to the task of rendering through it a public service that will measure up to your ideals.

# Presentation to Dr. Hogg

A LITTLE ceremony, unique in all Hydro history, took place on the morning of Friday, September 16th, when Dr. Hogg was presented, on behalf of the staff, with a set of four English, silver, covered serving dishes and an illuminated address. The occasion was to mark his having completed twenty-five years of continuous service with the Commission and having been made its Chairman.

This was not the outcome of the ideas of any group or section, but rather the outcome and expression of a spontaneous feeling of happiness throughout the whole staff, not only in Toronto but in all parts of the province.

The dishes were made in London in 1822 by Paul Storr, the most noted silversmith of his generation. An examination of these dishes reveals the work of the master. The usual procedure would be casting the shell and gadroon decorations from moulds and then applying to the article. Evidently Storr was out to excel himself in this instance, and instead of applying the decoration in the usual way, he actually chased the shell and gadroon by hand on each cover. This set of covered dishes came from the home of the Earl of Lincoln last year. Each one bears the Coat-of-Arms of Henry Pelham, 4th Duke of Newcastle, who was born in 1785 and died in 1851.

The presentation was made in the presence of practically all of the Toronto staff by the President of the Hydro Club, he being the nearest

approach to a representative of the staff as a whole. Regret was expressed that it was not possible for every member of the Commission's staff to be present although the presentation was made possible by the whole-hearted co-operation of all departments.

# The Georgian Bay System

By Dr. Thomas H. Hogg

THIS occasion is interesting to me as it is the first time I have attended any convention of any Municipal Electric Association in an official capacity. Last winter, owing to illness, I missed the opportunity of meeting some of you at the midwinter convention of the O.M.E.A. For that meeting I had prepared a formal pronouncement on the Niagara system power situation. Fortunately there is no occasion to deliver a similar official discourse in respect to the Georgian Bay system. For this I am very glad as I would much prefer to get away from serious speech-making altogether. It seems, however, that I cannot escape entirely. This occasion seems to me to call for a brief review, in very general terms, of some of the most interesting aspects of the progress of the Georgian Bay system.

Before doing so, may I just say a few words about our more personal relationships. Since becoming Chairman of the Commission I have often thought how fortunate it is that I enjoy making new acquaintances and friends. That is why it is a pleasure for me to be with you to-day—to meet the officers and members of your Association and to learn at first hand something about you personally as well as something about the matters which engage the attention of your Association. Let me say that there is nothing more stimulating and interesting to me than to sit down with people who have a problem and seek to find a solution that appeals to all as fair and reasonable.

In my short experience as Chairman of the Commission I have already had considerable work of that nature to do. I like doing it because I like to have people feel that they are being fairly treated. So if ever you have any doubts about whether our actions are based upon a sufficient knowledge of your conditions, or give reasonable weight to local interests, please come and see us in Toronto. We will do our best to welcome *you* as you have welcomed us. Moreover, we will try to meet your views; should there be any difficulties to overcome we will be perfectly frank and will join with you in a common effort to reach some satisfactory conclusion.

Returning to my review of the affairs of the Georgian Bay system,

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An address given at the annual meeting of the Georgian Bay Municipal Electric Association, September 14, 1938.

## CONTENTS

**Vol. XXV No. 9**
**September, 1938**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

my message to you, the partner municipalities comprising this large Georgian Bay system, contains some very good news. It will show that you have not only lived up to our expectations, in the way of sound, solid growth, but you even have surpassed them.

You all know that the Georgian Bay system had modest beginnings in several localities. Very considerable courage on the part of the municipalities which shouldered the initial financial responsibility was required in each case. You have at Wasdell falls the first plant constructed by the Commission away back in 1914; it operates under a 12-foot head which is the lowest head of any plant constructed by the Commission.

In contrast with this the Commission's next development at Eugenia falls has a 550-foot head, the highest of any hydro-electric plant in Ontario. Next came the purchase of the South Falls plant from Gravenhurst, and then the Big Chute plant from the Simcoe Railway and Power Company. These were the beginnings of the Wasdells, Eugenia, Muskoka and Severn systems. But it soon became apparent that interconnection of these small systems would be mutually advantageous to all and this led to their amalgamation into the Georgian Bay system. The process of amalagamation commenced in 1924 and was completed in 1925. By this means the physical and economic resources of the smaller systems have been co-ordinated and merged into one large self-sustaining system; a system that utilizes all its resources in the most economic manner possible and at the same time provides proper protection against breakdowns. This co-ordination has been especially helpful owing to the characteristics of some of the plants in question. Eugenia, for example, with its ample storage capacity wholly under the Commission's control, is always able to deliver its maximum output although, on account of water conditions, it may not be expedient to use the maximum output at a high load factor; in other words, for any considerable length of time each day. On the other hand, most of the plants on other sections of the system are better suited for the supply of base load with the result that an inter-

connection of the two is mutually very advantageous.

As you well know, the co-ordination of all the existing plants on the Georgian Bay system was not sufficient in itself to supply this territory with all the power it needed during recent years. In addition to taking all the power generated from ten plants, at South Falls, Hanna Chute, Trethewey Falls, Bala No. 1 and No. 2, Big Chute, Wasdell Falls, Eugenia Falls, Hanover and Walkerton, totalling 25,800 horsepower, power also had to be taken from the Niagara system through frequency changer stations at Hanover and Mount Forest, and also at the time of the peak demand this supply was augmented by 2,000 horsepower obtained from the Orillia Water, Light and Power Commission. In all, the system peak amounted to 35,500 horsepower.

The large amounts of power totalling nearly 12,000 horsepower, being drawn from these latter sources, which do not belong to the system, is in itself evidence that the time had arrived for a further development within the Georgian Bay territory which would be self-sustaining. The new plant at Ragged rapids on the Musquash river was begun in the spring of 1937. In a few weeks' time it will be in operation and will add some 10,000 horsepower to the peak capacity of the system.

For years prior to the formation of the Georgian Bay system, interconnection had been provided to a limited extent between the Eugenia system on the west and the Severn and Wasdell systems on the east. While this interconnection was very desirable, the amounts of power actually interchanged at various seasons of the year between the Eugenia district and the Severn and Wasdell districts, was relatively small at first. As the demands for power grew and additional generating stations were provided in the easterly portion of the system, a surplus capacity became available there which had to be transmitted through Waubaushene to the westerly portion of the system. This ultimately overtaxed the existing transmission facilities.

Now, to meet new conditions arising out of your new Ragged Rapids development, it has become necessary to substantially strengthen your transmission network. In order to augment its capacity the Commission has constructed new lines from Big Chute to Waubaushene and from Waubaushene to Fergusonvale. From Fergusonvale to Eugenia, existing transmission lines have been reinsulated for operation at 38,000 volts as against 22,000 volts formerly employed. From Ragged Rapids to Fergusonvale this new transmission link has been so designed that it will provide for further future development on the Musquash river. It may be converted at relatively small cost for operation at 110,000 volts and when that step becomes necessary it will probably also be extended through to Hanover. In this way a firm backbone for the ebb and flow of primary power can be provided, making it possible to transmit power surpluses over and above the needs of the Georgian Bay system to Hanover, and through the existing frequency

changer set there, to the Niagara system; a very desirable arrangement.

The Musquash river on which the Ragged Rapids plant is developed presents an unusual topographical feature in that the flow of this river divides about five miles below Muskoka lake and pursues two entirely different courses to the Georgian bay; the northern channel known as the Moon river and the southern as the Musquash river. In the development of this site the surplus flow of the Moon river was diverted into the Musquash as the latter afforded much more favorable conditions for economical development.

The flow on the Musquash river is subject to considerable variation and in order to secure maximum output from water available at all times, turbines particularly adapted for variable flows are being installed. These turbines have a peculiar mechanical arrangement. Not only are the gates which control the flow of water adjusted for any required load, but also the actual blades on the turbine runner itself are brought into the best position for the particular power demanded. A maximum efficiency for any given load is obtained from this most modern type of unit.

It has occurred to me that it would be a fitting thing for your Association and this Commission to join together in marking the opening of this fine new development by a fitting ceremony; the form which this ceremony might take and the question of just who should participate in it, I think may well be left in your hands; however, the Commission is willing to take care of all expenses and see that your ideas are carried out. I understand your executive are favourably disposed to the idea and I hope that the occasion will be successful.

What the future will bring forth we do not know, but if the system continues to grow as it has done in the past, it will be a relatively simple and inexpensive proposition to carry on this gradual process of co-ordination. You have several undeveloped power sites with favourable physical characteristics on the Musquash river at Big Eddy, Sandy Gray and Go Home, although it may be more economical to first reconstruct the plants at Bala to give additional power output when it is needed.

The Georgian Bay system is unique among all the systems of the Commission in that summer is the season of maximum demand. This, of course, is due to the relatively heavy consumption of power at summer resorts, but it has its disadvantages for quite often the flow of your rivers is very low at that time. Fortunately, the deficiency can be made up in two ways: first, from the excellent storage facilities afforded by the Eugenia basin, and, second, from the Niagara system through existing frequency changer sets. This latter reserve, which is made available to the Georgian Bay system without the payment of any charge for holding power in reserve, is particularly advantageous to the Georgian Bay system and, incidentally, the Niagara system is not penalized by the arrangement because Niagara system demands are at a minimum during the summer months; consequently the interchange is mutually beneficial to

both systems. At times the Georgian Bay assists the Niagara system by supplying power which enables maintenance work in certain districts to be carried out more advantageously.

From the foregoing brief review of power supplies and distribution facilities it will be appreciated that the whole of the Georgian Bay system transmission networks and generating stations function as a co-ordinated unit to produce a maximum reliability of service, with the greatest economy to all districts concerned.

Now, too many figures may be boring to a gathering such as this, but I *do* want to refer to a few just to give you an idea of the sound economic growth that has taken place on your system over the past 10 years.

During this period the increase in the number of urban municipalities in partnership in the system has been small; from 52 to 59. The increased growth of the system is not, therefore, attributable in any large measure to an increase in the number of municipalities served, but rather to an increased use of service by the people at large, especially in the rural districts.

During the decade, the capital invested by the Commission on behalf of the Georgian Bay system has increased by 80 per cent. from a little over 5 millions of dollars to more than 9½ millions of dollars. But during this time the reserves have more than tripled, from 1 1/3 millions of dollars to 4¼ millions of dollars. In other words, you have the lowest ratio of capital to reserves, at 2¼ to 1, of any system in the province. This means that your system has remarkable financial stability.

The foregoing figures relate of course to the wholesale or co-operative undertaking administered by the Commission for the Georgian Bay system municipalities. The total equity acquired by the municipalities through cost of power payments reached a total of nearly 1 1/3 millions of dollars in 1937, a 270 per cent. increase over 1927.

Turning now to the local municipal utilities, we find an equally satisfactory record. The total assets have increased 55 per cent. in ten years from 3 millions of dollars to 4¾ millions of dollars. On the other hand, the total liabilities have actually decreased by nearly 50 per cent. from nearly a million dollars to less than half a million dollars. In keeping with this achievement the local reserves and surplus have increased over 60 per cent. from 1,800,000 dollars to nearly 3,000,000 dollars.

The reason for this remarkable record is of course the increasing use of electric service at low cost which has brought with it about a 25 per cent. increase in total revenues; the amount of domestic revenues alone has almost doubled in spite of the many rate reductions.

Your Secretary has asked for information regarding the establishment of a stabilization of rates fund for the Georgian Bay system. While I do not intend to discuss this in detail, I feel that it is a very important matter on which my general views may be of interest to you. Information in greater detail will be furnished if you desire it.

The stabilization of rates fund is intended to prevent objectionable variations in the cost of power. These variations may have a number of causes, an important one of which is the cost of power generated and purchased. From time to time the growing needs of a power system require the development or purchase of additional power supplies. To assure the availability of additional power when needed, definite financial commitments must be made in advance of needs. They may be made either in the form of money invested in a generating station and transmission line, or in the form of a contract for power to be purchased according to a schedule, whether needed or not. If the load does *not* grow as expected, the system must bear the increased cost of power notwithstanding; also even if the system load *does* grow as expected the new commitments may cause a temporary rise in the cost of power actually used.

When considering where to develop power, every effort is made to choose a site which results in the best economy for the system over a period of years. This not infrequently requires the development of a comparatively large site, as was the case of the large Queenston plant of the Niagara system. In fact the site may be so large that even if the load grows as expected an increase in the cost of power actually used is bound to occur for a few years, but when the plant becomes more fully loaded, power costs to the consumer will usually return to an even lower level than they were before the plant was built.

It is obviously undesirable to have fluctuating rates for electrical service. Fluctuating rates create a sense of uncertainty and tend to frighten away potential users. Consequently, when a system is making maximum use of all its facilities and, in consequence, its per horsepower costs are at a minimum, funds should be set aside so that they will be available as a reserve to draw upon when needed. If this is done, temporary failure of load to grow as expected, or additional expense caused through the development of a large power site, need cause no disturbance in rates, since funds will be available to take care of the temporary deficiencies.

The development of your own Ragged Rapids plant is a case in point. Although you are fortunate in having been able to defer this development until the last minute, and, further in being able to be relieved of the cost of power formerly purchased from the Niagara system and Orillia, yet this 10,000 horsepower plant represents between one-quarter and one-third of your present demand for power and for a few years it may tend to increase the cost.

During the last fiscal year nearly $80,000 was saved and set aside in a reserve fund for rate stabilization. An equal or greater sum can readily be added to this reserve during the present year and, if need be, the combined amount can be drawn upon during the next following year or two so that no increase in your rates will be necessary.

In principle there can be no doubt whatever as to the advisability of having a rate stabilization fund for the Georgian Bay system. Although, as

compared with the Niagara system you were remarkably successful in weathering the depression, your success was partly due to the fact that you have not such a large proportion of large industrial customers which are affected by export conditions, but, notwithstanding your own inherent stability and your comparative assurance of continuing to go forward at a normal gait, you still have need of a rate stabilization fund. At the moment there is no occasion for concern as to how much this fund will be allowed to grow; this is a question for the future but you may be sure that this Commission will give careful consideration to that phase of the matter at the proper time and that your views and wishes will be taken into account.

When we review the progress made in bringing the benefits of electrical service to rural citizens the results in the Georgian Bay system during the past ten years are also a matter for great satisfaction. The progress made, merits the description, "phenomenal". The miles of primary line in 1927 were less than 110 miles. At the end of 1937, there were nearly 1,600 miles constructed. The number of consumers had increased from less than 1,000 to more than 10,000. The capital invested in the rural power districts had increased from less than ¼ million dollars to over 2½ millions. The government grant-in-aid had increased from $100,000 to nearly 1 1/3 millions. And from the small power load of 367 h.p. in October, 1927, a load of over 4,000 h.p. was recorded in October, 1937. Due to the summer resort and cottage demands the aggregate rural load this summer exceeded 7,500 h.p. During the decade, the rural power districts increased from 21 to 48, and year by year the primary lines reach out to serve the more remote farms and hamlets. It is interesting to note that in 1937 there was approved for construction an expenditure of well over one million dollars to build nearly 500 miles of primary line to give service to over 1,100 hamlet and nearly 1,300 farm customers; a total of 2,400 new consumers, or nearly three times as many consumers as were served in 1927, were connected in this year alone. It is also interesting to note that in 1937 alone, lines were extended to give service to five times the total number of farms served in 1927.

In closing, I think you will agree with me that the brief survey indicates:

(1) that your system is very sound financially;

(2) that it is being carefully and systematically co-ordinated into a reliable and economic power system;

(3) that considering the absence of large industrial areas in this territory with their accompanying heavy load demands, the Georgian Bay system has been able to give a remarkably fine service at low cost.

It is my sincere hope that the Georgian Bay system will continue to maintain this fine record.

# Use of Hydro Continues to Grow Steadily

## Consumption and Revenue of Domestic, Commercial and Rural Services for the Year 1937 Compared With Former Years

By G. J. Mickler, B.A.Sc., Sales Department, H.E.P.C. of Ontario

THE use of electricity among all classes of Hydro consumers showed a very substantial increase during the year 1937 over former years, an increase which is due almost entirely, at least so far as urban consumers are concerned, to added use by existing customers. In the case of rural consumers it is due in no small measure to the increase in the number of consumers served as well as to the increased use by those who have been receiving service for a number of years.

In the tables of revenue and consumption which follow it is evident that there is a gradual increase in the rate of use by all classes of consumers, due in part to the activities of the Commission in promoting electric cooking, water heating, better lighting and electrified farming, as well as the gradual improvement in employment conditions which has its effect on the buying power of Hydro consumers throughout the province.

The following tables show the growth in revenue, consumption and in the number of consumers served from year to year since 1913 and they are divided into three general classes—Domestic Service, Commercial Service and Rural Service.

TABLE NO. I
DATA FOR CITIES OVER 10,000 POPULATION
DOMESTIC SERVICE

| Year | No. of Municipalities | Annual Revenue | Kilowatt-Hours Consumed | Number of Consumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 12 | $ 614,925.00 | 12,646,400 | 55,597 | 4.86c | $1.06 | 21.8 |
| 1917 | 19 | 1,063,264.00 | 36,693,100 | 107,248 | 2.89 | .88 | 30.5 |
| 1920 | 21 | 1,926,924.00 | 84,328,000 | 154,186 | 2.29 | 1.11 | 48.4 |
| 1923 | 21 | 3,772,416.00 | 206,266,200 | 223,028 | 1.83 | 1.53 | 83.5 |
| 1927 | 24 | 6,086,753.11 | 371,945,485 | 276,632 | 1.63 | 1.87 | 114.4 |
| 1930 | 26 | 7,921,316.00 | 541,876,998 | 315,611 | 1.46 | 2.11 | 144.4 |
| 1933 | 26 | 8,495,321.93 | 595,211,863 | 330,597 | 1.43 | 2.14 | 150.0 |
| 1936 | 26 | 9,743,001.62 | 720,002,863 | 350,083 | 1.35 | 2.32 | 171.4 |
| 1937 | 26 | 9,557,649.65 | 752,498,158 | 353,826 | 1.27 | 2.25 | 177.2 |

## TABLE NO. II

### DATA FOR TOWNS OVER 2,000 POPULATION

### DOMESTIC SERVICE

| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Con-sumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 19 | $ 90,330.00 | 1,414,500 | 7,410 | 6.38c | $1.11 | 17.4 |
| 1917 | 27 | 180,075.00 | 3,824,600 | 15,731 | 4.71 | 1.01 | 21.4 |
| 1920 | 36 | 353,915.00 | 10,053,100 | 24,041 | 3.50 | 1.26 | 36.0 |
| 1923 | 43 | 651,499.00 | 25,411,300 | 34,135 | 2.56 | 1.57 | 60.1 |
| 1927 | 55 | 1,325,096.89 | 62,105,723 | 56,813 | 2.13 | 1.99 | 92.9 |
| 1930 | 53 | 1,468,194.00 | 73,234,125 | 58,490 | 2.01 | 2.10 | 105.0 |
| 1933 | 60 | 1,584,772.57 | 82,321,996 | 63,910 | 1.92 | 2.07 | 107.3 |
| 1936 | 57 | 1,460,916.64 | 80,678,385 | 61,102 | 1.81 | 1.99 | 110.1 |
| 1937 | 57 | 1,428,387.72 | 86,912,430 | 63,067 | 1.64 | 1.89 | 114.8 |

## TABLE NO. III

### DATA FOR VILLAGES UNDER 2,000 POPULATION

### DOMESTIC SERVICE

| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Con-sumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 18 | $ 24,913.00 | 291,000 | 1,859 | 8.55c | $1.10 | 13.1 |
| 1917 | 77 | 97,516.00 | 1,412,500 | 8,334 | 6.90 | .96 | 14.0 |
| 1920 | 109 | 233,819.00 | 3,829,900 | 15,665 | 6.00 | 1.29 | 21.2 |
| 1923 | 142 | 531,505.00 | 11,249,100 | 29,689 | 4.72 | 1.59 | 33.7 |
| 1927 | 188 | 1,095,340.79 | 35,900,482 | 52,088 | 3.05 | 1.81 | 59.5 |
| 1930 | 194 | 1,363,210.00 | 55,917,187 | 59,159 | 2.43 | 1.95 | 80.1 |
| 1933 | 214 | 1,559,083.62 | 64,651,543 | 66,371 | 2.41 | 1.96 | 81.2 |
| 1936 | 219 | 1,718,548.21 | 81,291,076 | 71,372 | 2.11 | 2.01 | 94.9 |
| 1937 | 221 | 1,694,844.21 | 86,940,142 | 73,247 | 1.95 | 1.93 | 98.9 |

## TABLE NO. IV

### ALL MUNICIPALITIES TOTALLED

### DOMESTIC SERVICE

| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Con-sumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 49 | $ 730,168.00 | 14,359,100 | 64,866 | 5.08c | $1.06 | 21.0 |
| 1917 | 123 | 1,340,855.00 | 41,930,200 | 131,313 | 3.20 | .91 | 28.6 |
| 1920 | 166 | 2,514,658.00 | 98,211,000 | 193,892 | 2.56 | 1.15 | 44.6 |
| 1923 | 206 | 4,955,420.00 | 242,926,600 | 286,852 | 2.04 | 1.54 | 75.7 |
| 1927 | 267 | 8,497,190.79 | 469,851,690 | 387,573 | 1.80 | 1.87 | 103.5 |
| 1930 | 273 | 10,752,720.00 | 671,028,310 | 433,260 | 1.61 | 2.09 | 130.1 |
| 1933 | 300 | 11,639,178.12 | 742,195,402 | 460,878 | 1.57 | 2.10 | 134.2 |
| 1936 | 302 | 12,922,466.47 | 881,972,324 | 482,557 | 1.47 | 2.23 | 152.3 |
| 1937 | 304 | 12,680,921.58 | 926,350,703 | 490,140 | 1.37 | 2.16 | 157.5 |

GROWTH OF DOMESTIC SERVICE

Table No. I provides data for domestic consumers in cities of over 10,000 population, showing the annual revenue, annual consumption, number of consumers, the average cost per kilowatt-hour, also the average monthly bill and the average monthly consumption.

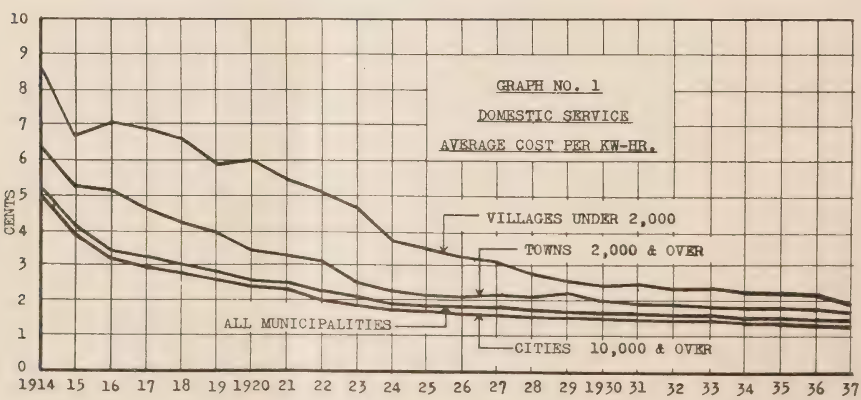
This table reveals the fact that there has been a steady increase in both revenue and consumption since the year 1933 and that there is a very substantial increase in consumption during the past year, while the revenue has decreased. The latter condition is caused by the revision of rates in most Hydro municipalities, dispensing with the old service charge and substituting for it the new standard form of two step domestic rate. This also had the effect of reducing the average monthly bill and the average cost per kilowatt-hour while the average monthly consumption showed a substantial increase.

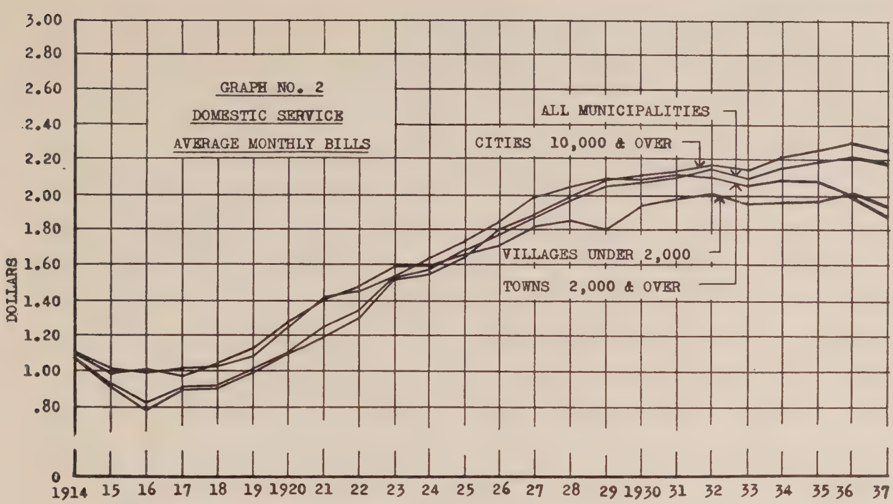
Table No. II provides similar data for domestic consumers in towns of 2,000 and over population. Here again there is an increase in consumption but a decrease in revenue and a corresponding decrease in the average monthly bill and the average cost per kilowatt-hour, while the average monthly consumption advanced.

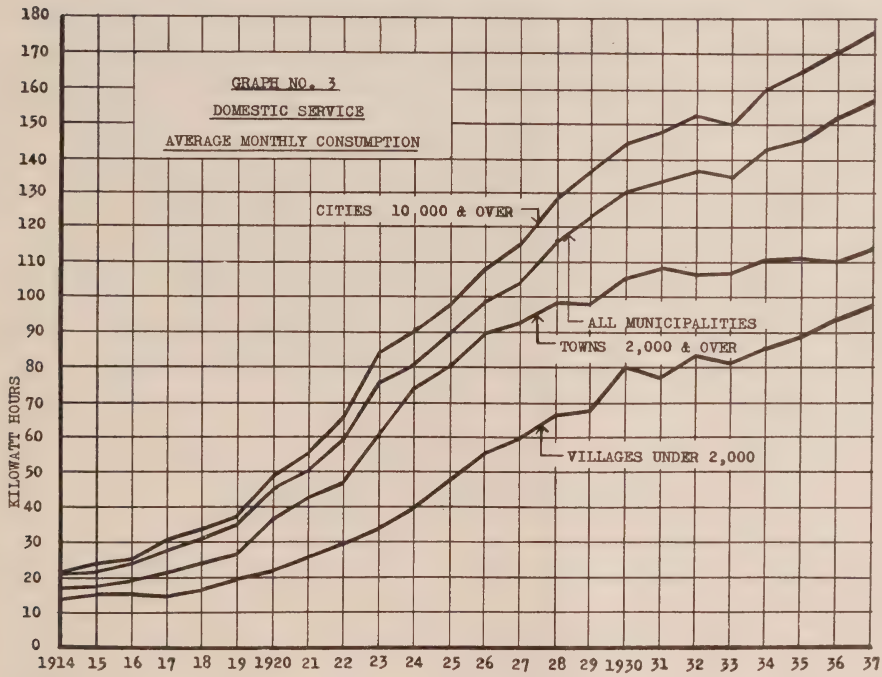
Table No. III provides similar information for villages under 2,000 population and in general the same conditions prevail as in the cities and towns.

Table No. IV summarizes the results for all domestic consumers in all types of municipalities. An examination of these figures reveals the fact that from 1933 to 1937 there has been an increase of 25 per cent. in the total domestic consumption while the number of consumers increased less than 7 per cent. and the average cost per kilowatt-hour during the same period dropped from 1.57c to 1.37c and the average monthly consumption rose from 134.2 kilowatt-hours to 157.5 kilowatt-hours per month.

It is interesting to note the growth in the average monthly consumption during the past 20 years. In 1917 the average monthly consumption was 28.6 kilowatt-hours; in 1927, 103.5 kilowatt-hours and in 1937, 157.5 kilowatt-hours. It is interesting also to compare the average monthly con-






sumptions for the year 1937 in cities, towns and villages. The average monthly consumption for cities was 177.2 kilowatt-hours, for towns 114.8 kilowatt-hours and for villages 98.9 kilowatt-hours. The average for all municipalities was 157.5 kilowatt-hours.

The growth in the use of electricity by domestic consumers is further illustrated by graphs.

Graph No. 1 shows the variations

in the average cost per kilowatt-hour for each of the four groups of municipalities included in Tables Nos. I, II, III and IV.

Graph No. 2 shows the variations in the average monthly bill among the same groups of domestic consumers.

Graph No. 3 shows the growth in the average monthly consumption.

### GROWTH OF COMMERCIAL USE

In the tables of revenue and consumption for commercial consumers which follow will be seen the effect of improvement in industrial conditions, lowering of commercial lighting rates and the promotional efforts that have been put forward during the past few years to improve industrial and commercial lighting conditions.

Table No. V provides data for cities of over 10,000 population showing the annual revenue, annual consumption, the number of consumers, the average cost per kilowatt-hour as well as the average monthly bill and the average monthly consumption.

This table shows a substantial decrease in revenue during the past year, but shows also a very substantial increase in the consumption, with a very slight increase in the number of consumers served and the effect of these conditions is a lowering in the average cost per kilowatt-hour and in the average monthly bill with a substantial increase in the average monthly consumption. The decrease in revenue is due to a revision in commercial lighting rates.

Table No. VI shows the growth of commercial use in towns of 2,000 and over population. This table shows a slight increase in the revenue and in the consumption, as well as in the number of consumers served, but the average cost per kilowatt-hour is down and the average monthly consumption is up considerably.

Table No. VII provides data for villages of under 2,000 population. As in the case of the towns there is an increase in the annual revenue and in the annual consumption, also in the number of consumers served, but the average cost per kilowatt-hour is down

TABLE NO. V
DATA FOR CITIES OVER 10,000 POPULATION
COMMERCIAL LIGHTING SERVICE

| Year | No. of Municipalities | Annual Revenue | Kilowatt-Hours Consumed | Number of Consumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 12 | $ 536,350.00 | 14,048,500 | 12,439 | 3.80c | $3.94 | 103.7 |
| 1917 | 19 | 642,989.00 | 27,479,800 | 19,573 | 2.34 | 2.96 | 126.6 |
| 1920 | 21 | 1,103,599.00 | 50,358,000 | 25,505 | 2.19 | 3.77 | 172.0 |
| 1923 | 21 | 2,043,197.00 | 91,146,500 | 32,016 | 2.25 | 5.56 | 246.9 |
| 1927 | 24 | 3,844,501.17 | 169,213,258 | 43,702 | 2.27 | 7.49 | 329.2 |
| 1930 | 26 | 4,919,496.00 | 242,278,308 | 50,046 | 2.03 | 8.31 | 409.6 |
| 1933 | 26 | 4,910,798.54 | 242,854,622 | 51,769 | 2.02 | 7.90 | 390.9 |
| 1936 | 26 | 5,673,317.44 | 298,250.755 | 52,058 | 1.90 | 9.08 | 477.4 |
| 1937 | 26 | 5,309,814.19 | 329,007,570 | 52,311 | 1.61 | 8.46 | 524.1 |

## TABLE NO. VI
### DATA FOR TOWNS OVER 2,000 POPULATION
### COMMERCIAL SERVICE

| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Con-sumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 17 | $ 71,457.00 | 1,362,000 | 2,393 | 5.25c | $2.61 | 49.8 |
| 1917 | 27 | 134,730.00 | 3,100,600 | 4,107 | 4.35 | 2.76 | 63.5 |
| 1920 | 36 | 221,867.00 | 6,179,400 | 5,736 | 3.59 | 3.30 | 91.8 |
| 1923 | 43 | 315,530.00 | 9,598,000 | 7,086 | 3.29 | 3.76 | 114.3 |
| 1927 | 56 | 560,479.40 | 20,372,460 | 10,054 | 2.79 | 4.79 | 172.3 |
| 1930 | 54 | 661,857.00 | 27,841,568 | 10,274 | 2.38 | 5.38 | 226.4 |
| 1933 | 60 | 663,596.72 | 29,864,388 | 10,966 | 2.22 | 5.04 | 226.9 |
| 1936 | 57 | 687,355.93 | 32,957,583 | 10,600 | 2.09 | 5.40 | 259.1 |
| 1937 | 57 | 704,091.44 | 37,152,569 | 10,846 | 1.90 | 5.41 | 285.5 |

## TABLE NO. VII
### DATA FOR VILLAGES UNDER 2,000 POPULATION
### COMMERCIAL LIGHTING SERVICE

| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Con-sumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 14 | $ 16,974.00 | 259,200 | 825 | 6.55c | $1.74 | 26.6 |
| 1917 | 77 | 82,756.00 | 1,403,100 | 3,773 | 5.86 | 1.87 | 31.7 |
| 1920 | 109 | 152,497.00 | 2,799,500 | 5,255 | 5.89 | 2.45 | 45.0 |
| 1923 | 142 | 254,530.00 | 4,738,100 | 7,281 | 4.80 | 2.96 | 55.1 |
| 1927 | 188 | 418,800.80 | 11,020,419 | 10,283 | 3.80 | 3.50 | 91.9 |
| 1930 | 193 | 513,518.00 | 17,718,146 | 11,553 | 2.89 | 3.76 | 129.9 |
| 1933 | 214 | 575,396.85 | 19,616,479 | 12,708 | 2.93 | 3.77 | 128.6 |
| 1936 | 219 | 641,220.20 | 24,027,215 | 13,220 | 2.67 | 4.04 | 151.5 |
| 1937 | 221 | 663,062.45 | 26,906,980 | 13,463 | 2.46 | 4.10 | 166.5 |

## TABLE NO. VIII
### ALL MUNICIPALITIES TOTALLED
### COMMERCIAL LIGHTING SERVICE

| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Con-sumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 43 | $ 624,781.00 | 15,669,700 | 15,657 | 4.00c | $3.63 | 90.8 |
| 1917 | 123 | 860,475.00 | 31,983,500 | 27,453 | 2.69 | 2.77 | 103.1 |
| 1920 | 166 | 1,477,963.00 | 59,336,900 | 36,496 | 2.50 | 3.51 | 140.0 |
| 1923 | 206 | 2,613,257.00 | 105,482,600 | 46,383 | 2.46 | 4.80 | 195.6 |
| 1927 | 268 | 4,823,781.37 | 200,606,137 | 64,039 | 2.40 | 6.39 | 266.7 |
| 1930 | 273 | 6,094,871.00 | 287,838,022 | 71,873 | 2.11 | 7.15 | 337.8 |
| 1933 | 300 | 6,149,792.11 | 292,335,489 | 75,443 | 2.10 | 6.79 | 322.9 |
| 1936 | 302 | 7,001,893.57 | 355,235,553 | 75,878 | 1.97 | 7.69 | 390.1 |
| 1937 | 304 | 6,676,968.08 | 393,067,119 | 76,620 | 1.70 | 7.26 | 427.5 |

and the average monthly consumption is up.

Table No. VIII summarizes the information contained in Tables Nos. V, VI and VII. These figures show a decrease in the total commercial revenue with an increase in the consumption, and a small increase in the number of consumers served with a substantial decrease in the average cost per kilowatt-hour and the average monthly bill and an increase of almost 10 per cent. in the average monthly consumption.

In comparing these results with former years it may be interesting to note from 1933 to 1937 there is an increase of 34 per cent. in the total commercial consumption in the province while the number of consumers served increased only 1½ per cent. The average cost per kilowatt-hour dropped from 2.1c in 1933 to 1.7c in 1937. The average monthly bill dropped from $7.69 in 1936 to $7.26 in 1937, owing to a reduction in the rates, and the average monthly consumption rose from 322.9 kilowatt-hours in 1933 to 427.5 kilowatt-hours per month in 1937.

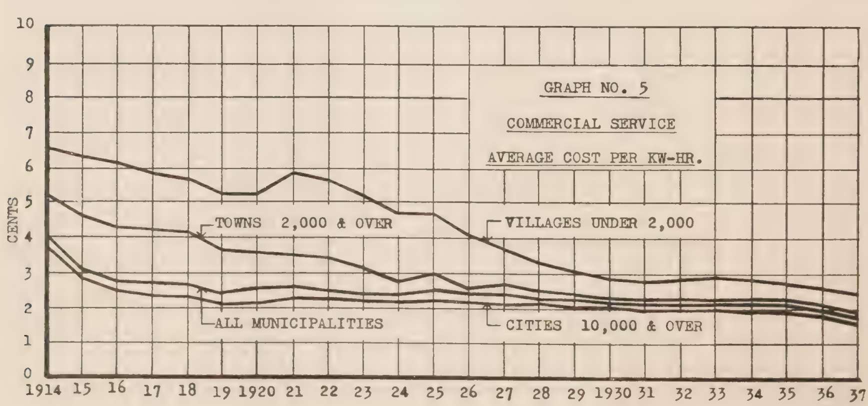
It is interesting also to note the growth in the average monthly consumption in 10 year periods from 1917 on. In 1917 the average monthly commercial consumption was 103.1 kilowatt-hours; in 1927, 266.7 kilowatt-hours; in 1937, 427.5 kilowatt-hours.

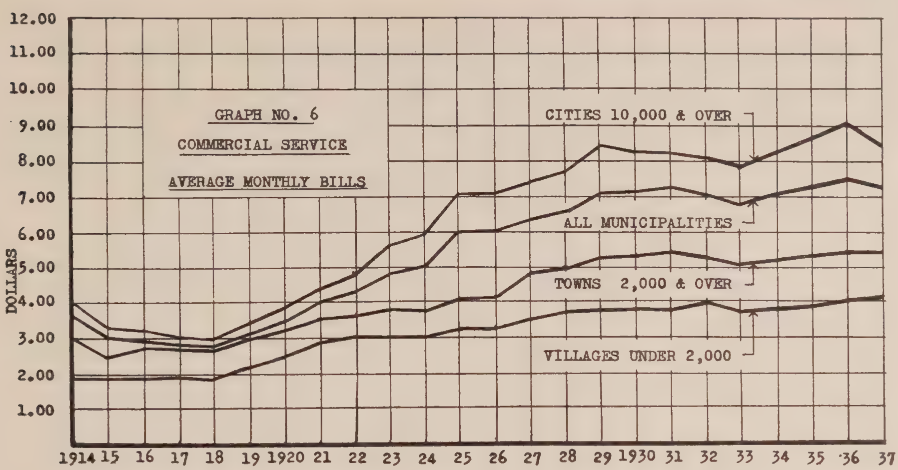
The results shown in Tables Nos. V, VI, VII and VIII are graphically illustrated in Graphs 5, 6 and 7.

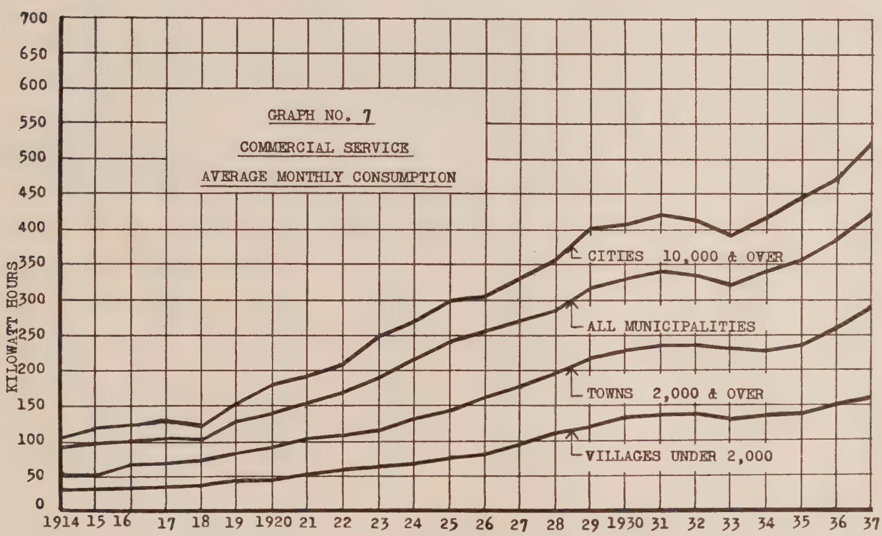
### Growth in Rural Use

Table No. IX gives information on the use of Hydro by hamlet consumers in Hydro rural power districts. The figures in this table reveal a gradual increase in the annual revenue and in consumption, with a very substantial increase in the number of consumers served and a corresponding decrease in the average revenue per kilowatt-hour and in the average monthly bill, while the average monthly consumption has increased.

Owing to the fact that a large number of hamlet consumers have been added each year during the past 2 or 3 years and that these consumers take time to become accustomed to the use of electricity and are slow to add new electrical equipment to that already in use, the average monthly consumption






does not grow as rapidly as it otherwise would. That is to say, the low consumption of new consumers who bear a fair ratio to the total number of consumers served tends to keep the average of all consumers down. It may be said, however, that after a few years hamlet consumers take to the use of electrical appliances almost as readily as urban consumers in the province.

Table No. X shows the growth in revenue, consumption and in the number of farm consumers served during the past 10 years as well as the variations in the average revenue per kilowatt-hour, the average monthly bill and the average monthly consumption. It will be noted from this table that the revenue for 1937 is less than for 1936 due in no small measure to the

TABLE NO. IX
DATA FOR RURAL POWER DISTRICTS
HAMLET SERVICE

| Year | Annual Revenue | Kilowatt-Hours Consumed | Number of Consumers *Billed | Average Revenue Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|
| 1928 | $ 530,407.00 | 10,702,031 | 17,585 | 4.95c | $2.51 | 50.7 |
| 1929 | 663,311.00 | 14,424,770 | 21,219 | 4.60 | 2.85 | 62.0 |
| 1930 | 757,558.00 | 17,815,987 | 25,013 | 4.25 | 2.73 | 64.2 |
| 1931 | 974,224.17 | 22,127,474 | 31,176 | 4.40 | 2.88 | 65.6 |
| 1932 | 1,075,081.03 | 24,654,386 | 33,638 | 4.36 | 2.76 | 63.3 |
| 1933 | 1,133,368.70 | 25,410,470 | 35,941 | 4.46 | 2.70 | 60.1 |
| 1934 | 1,149,876.67 | 27,768,460 | 37,466 | 4.14 | 2.61 | 63.0 |
| 1935 | 1,171,873.28 | 30,802,290 | 39,751 | 3.80 | 2.53 | 66.5 |
| 1936 | 1,239,010.83 | 35,666,241 | 43,014 | 3.47 | 2.49 | 71.8 |
| 1937 | 1,331,919.46 | 40,935,040 | 46,785 | 3.25 | 2.47 | 76.0 |

TABLE NO. X
DATA FOR RURAL POWER DISTRICTS
FARM SERVICE

| Year | Annual Revenue | Kilowatt-Hours Consumed | Number of Consumers *Billed | Average Revenue Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|
| 1928 | $ 569,007.00 | 10,969,828 | 9,309 | 5.18c | $4.97 | 96.1 |
| 1929 | 777,736.00 | 16,022,842 | 12,605 | 4.85 | 5.85 | 120.8 |
| 1930 | 863,805.00 | 20,507,063 | 16,011 | 4.21 | 5.03 | 119.4 |
| 1931 | 1,128,554.28 | 25,716,141 | 20,796 | 4.39 | 5.11 | 116.4 |
| 1932 | 1,255,482.13 | 28,675,400 | 22,432 | 4.38 | 4.84 | 110.5 |
| 1933 | 1,309,122.96 | 30,062,194 | 23,283 | 4.35 | 4.75 | 109.2 |
| 1934 | 1,319,922.69 | 33,312,314 | 23,882 | 3.96 | 4.66 | 117.7 |
| 1935 | 1,343,222.39 | 37,667,453 | 25,357 | 3.57 | 4.55 | 127.5 |
| 1936 | 1,385,784.39 | 45,447,669 | 28,198 | 3.05 | 4.31 | 141.4 |
| 1937 | 1,366,484.50 | 54,858,240 | 35,508 | 2.49 | 3.57 | 143.5 |

*It may be observed that the number of consumers reported here does not agree with those shown in the Annual Report of the Commission. This is due to the fact that Class 2A consumers are considered as hamlet consumers in this report and as farm consumers in the Annual Report. Furthermore, the figures given here represent consumers actually billed, whereas the Annual Report shows the number of contracts executed to the end of each fiscal year. In many cases service is not given until the following year.

decrease in service charge in spite of a very substantial increase in the number of consumers served. The total consumption increased almost 20 per cent. and the number of consumers billed shows an increase of 7,400 consumers. The average revenue per kilowatt-hour shows a substantial reduction as does the average monthly bill, but the average monthly consumption has increased. Owing to the fact that a large number of consumers were added to the lines in 1937 and that these consumers would not make as full use of Hydro service as older consumers, the average monthly consumption has been kept lower than it otherwise would be.

# Economic and Other Aspects of Some Utility Metering Problems

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*(Presented to the Ontario Municipal Electric Association and the Association of Municipal Electrical Utilities at Bigwin Inn, Muskoka, July 6, 1938.)*

THIS paper is for the purpose of analyzing some of the metering problems which affect a utility economically.

### SERVICE SWITCH BOXES

Until within the last few years the wiring rules required service entrance switch boxes located on the supply side of the meter. The rules were changed several years ago to permit reversal of the sequence and the meter may now be connected on the supply side of the service entrance switch, and indeed under certain circumstances the service entrance switch may be omitted altogether.

Continual pressure of competition has caused a tendency toward making service entrance switches as cheaply as possible. This competitive situation has been so severe that certain manufacturers have even intimated that they cannot compete profitably and at the same time produce a switch of what they consider is proper quality. The possible adverse effect of this situation on the quality of service entrance switches will be evident.

The consumer, of course, has not paid any attention whatsoever to the question of quality of service entrance switches. He leaves the matter entirely to the wiring contractor, who in turn must keep his costs at a minimum due to the well known close price situation in the wiring business.

The net result of the situation is that unexpected and unforeseen power losses may occur in switch boxes due to the necessity of low cost construction. These losses may be small when the switch box is new, but after a prolonged period of service will increase considerably, particularly if heavily loaded.

These losses, where they occur, are of course the direct result of equipment installed by the consumer, innocently on his part, but nevertheless entirely beyond the control of the utility.

When the switch box is located on the supply side (old meter sequence) of the meter, the losses in such a switch box are not metered and are therefore borne by the utility and are a direct loss of revenue.

Tests made on switch box installations in service show losses as high as:—

15 watts per pole on 30 ampere switches.

From 15 to 45 watts per pole on 60 ampere switches.

The remedy for this power loss lies

*The author wishes to acknowledge the very valuable assistance given by Mr. W. G. Pengelley in the preparation of this paper.

entirely with the utility and consists merely of using *new sequence metering* (i.e. connecting the meter on the supply side of the entrance switch).

### New Sequence Metering

"New Sequence Metering" or so-called "Hot Metering" is the term applied to the service entrance system in which the meter is connected on the supply side of the service entrance switch or any other of the consumer's equipment. In other words, the meter becomes a part of the incoming supply line and no equipment of any kind is connected in the supply leads ahead of the meter.

New sequence metering is now permitted by the wiring regulations for circuits not exceeding 300 volts between conductors and not exceeding 100 amperes in capacity. It is intended primarily for domestic service.

The new sequence metering system is now used almost entirely throughout the United States. Not only has it become practically standard there for new services, but a large proportion of old services have been changed to new sequence.

This method of metering has been adopted to a considerable extent in Canada, and outside of Ontario certain large cities have either standardized on it, or are considering it seriously. In Ontario, however, some large cities have not given the new sequence metering any really serious consideration, and there is no apparent reason why they should be backward in this new development.

Obvious advantages of new sequence metering are:—It greatly reduces the opportunity of energy diversion by the consumer. By experience it has been found that this method eliminates all but a small proportion of tampering with services.

Since the use of new sequence metering makes it unnecessary for the consumer or anyone else excepting the utility, to have access to the connections on the supply side of a meter, the leads and connections on the supply side can be thoroughly protected up to the meter. In particular the service switch is no longer a device by which access can be had to circuit connections ahead of the meter.

The meter being energized at all times, tampering with it must be done while it is alive—which of course is dangerous to the person of the tamperer.

The use of new sequence metering also eliminates the necessity of sealing the service entrance switch box, relieves the utility of the cost of installing and maintaining the switch box seal, and what is possibly more important removes any cause there may be of dispute with the consumer on account of his having broken the seal for the purpose of replacing a fuse. The sealing of the switch box by the utility has been enforced with a varying degree of success and unless the switch box is sealed an old sequence installation can be very easily tampered with in many ways, and with small chance of detection.

Another advantage of new sequence metering is that it permits the use of outdoor meters.

### Outdoor Metering

Outdoor metering has developed rapidly in the last few years, being of course greatly facilitated by the use of the new sequence method.

Unquestionably outdoor metering is a development which has come to stay and is growing rapidly. As far as the author is aware, no utilities in Canada have discontinued the use of outdoor metering after having tried it out or commenced the use thereof.

All manufacturers in Canada are now offering metering equipment for outdoor service.

The features of outdoor metering are:—It is an almost certain deterrent against tampering and energy diversion. Locating the meter outdoors where anyone wishing access to it for the purpose of tampering will be in full view has an obviously psychological effect on the would-be tamperer. A meter reader can easily read four to six times as many outdoor meters as indoor meters in a given time under average conditions. All delay and difficulty in obtaining access to premises for the purpose of reading meters is avoided as is also the necessity of locating and reading inside meters which are in difficult and awkward positions.

There is no inconvenience or embarrassment of any kind caused the consumer by the meter reader. There are no missed readings and all necessity of returning to obtain such readings is avoided—and this is particularly advantageous in the case of premises where the occupants are not regularly at home during working hours, and where the premises are only occupied intermittently, such as in the case of summer cottages, etc.

The handling of meters is greatly facilitated when mounted outdoors. The replacing of a meter at the end of a Government seal period presents no difficulty whatsoever in this case as the meter installer is sure that he can obtain access to the meter without question. Similarly, if the premises become vacant the meter is readily obtainable without difficulty.

The position of the meter outdoors provides a means whereby the utility can disconnect the service without having access to the interior of the premises and without cutting service connections. This parallels the outdoor means of disconnection which has nearly always been available in the case of water and gas services, thus reducing the hazard of fire and energy diversion in premises vacant or presumably vacant.

Incidentally, several utilities in the United States found outdoor meters very advantageous during the flood conditions of a year or two ago. Knowing that some areas would be flooded they sent out service trucks and removed large numbers of outdoor detachable meters very quickly and handily and thus saved a large reconditioning or replacing expense.

In service entrances of the old type, where the meter is located on the second floor in a position such as a bedroom or bathroom, the use of the outdoor meter provides a very inexpensive and effective method of removing the meter from such out-of-date locations and placing it in an accessible and much more desirable position. See Fig. 1 for the method of making such an alteration from this obsolete form of service, without any expense to the consumer for rewiring and with exceptionally low cost to the utility. Since the meter is preferably located about seven feet

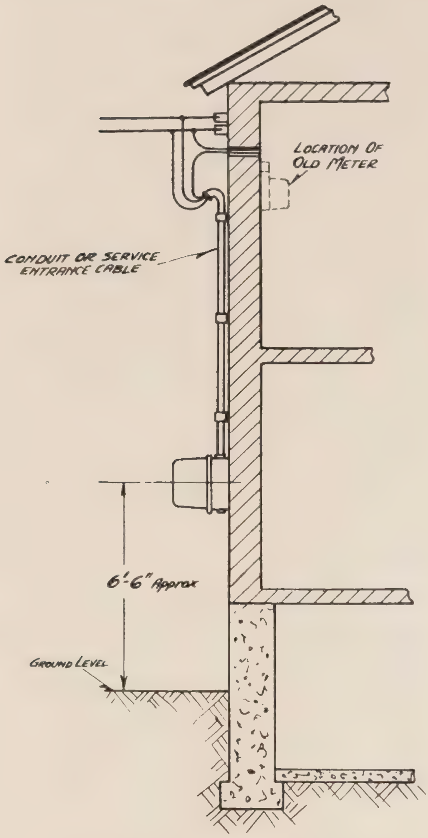



*Fig. 1—Type "CS" meter installation using existing entrance at the top floor of the building.*

above the ground level all necessity for protecting service entrance cable, as may be used for such an alteration, is avoided.

POLYPHASE METER INSTALLATIONS

The same attention has not been paid to, nor the same degree of effort put forth in, standardizing polyphase meter installations as in the case of single phase installations. The importance of the energy consumed per installation does, of course, justify a decided interest in the quality of polyphase installations.

Self-contained polyphase watthour meters are available in ratings of 5, 10, 15, 25 and 50 amperes up to and including 550 volts. For higher currents, current transformers must be used. For higher voltages both current and voltage transformers must be used.

The general practice has not been to overload polyphase meters, in the same manner that single phase meters have been. However, modern polyphase meters can be used on circuits where the current may continuously be as high as 200 per cent. or even more of the meter rating.

In addition to the lack of standardization in methods of polyphase installation there is the objectionable fact that many of such installations are often anything but neat and compact. Although much more revenue is involved per service unit than in the case of single phase installations, usually nothing like as much attention has been paid to proper installation of polyphase meters from the viewpoint of making the installation thoroughly tamper-proof. One polyphase installation which has been tampered with may cause a revenue loss exceeding that of a great number of similar single phase installations.

In Figs. 2 and 3 are shown a suitable box containing current transformers, and on the front of which box the meter can readily be mounted, the whole making a readily-installed, compact, neat and diversion-proof installation.

The through type current transformers used in this metering box are illustrated in Figs. 3 and 4. The current transformers, being through

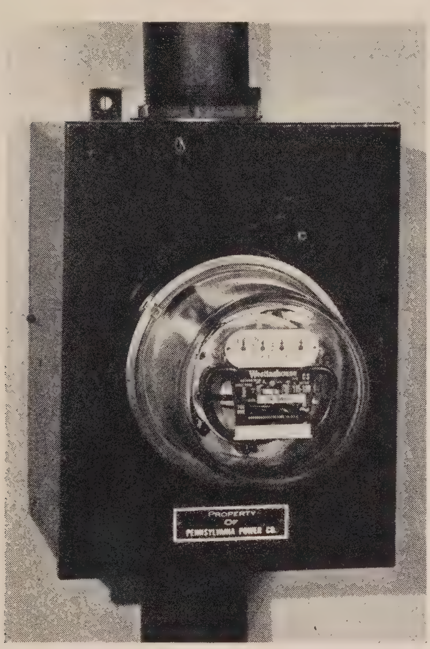



*Fig. 2—Box containing current transformers with meter mounted on front.*

type, facilitate the easy installation of the equipment, since it is only necessary to carry the conductor through the opening in the current transformer. The conductor is not broken, and cutting of leads, soldering of terminals, and similar work necessary with the ordinary type of current transformer is avoided. The current transformers being interchangeable mechanically, it is possible to change the capacity thereof very quickly and easily.

Such a metering box:—

Provides a very compact, uniform and neat mounting. Combines the current transformer enclosure with the meter mounting, making a complete, non-accessible and tamper-proof installation.

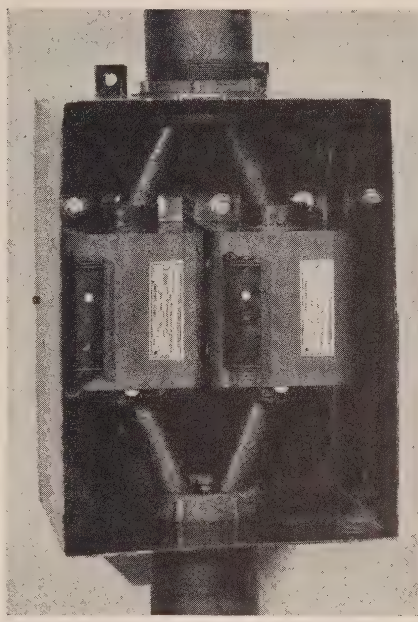


*Fig. 3—Current transformers mounted in box.*

Facilitates the ready changing of current transformers when different ratings are required.

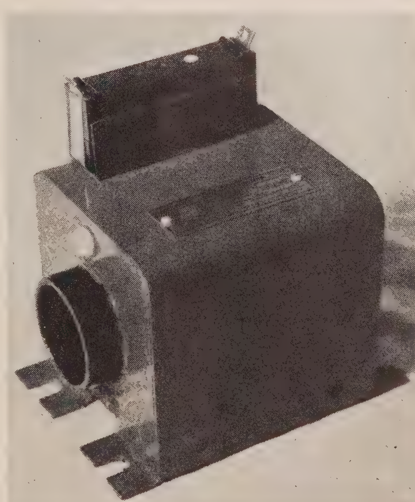


*Fig. 4—Through type current transformer.*

Provides a wide range of metering capacity with only a few ratings of current transformers, thus limiting the stock of current transformers required to be carried and making them more interchangeable for different services of the utility, with much less total investment in this form of equipment.

*(To be continued)*

# Meteors and Fireballs

THOSE narrow streaks of light which suddenly appear on clear moonless nights and last for only a second or two are the trails of shooting stars, "meteors," as they dart here and there in the sky,—Fig. 1. Other brighter bodies appearing on such nights and moving somewhat more slowly, often along a curved path, are known as "fireballs."

Both meteors and fireballs belong to our solar system and are material bodies which are revolving around our sun in long narrow elliptical orbits, under the same laws that govern the motions of the planets. When one of these bodies is meeting the earth,—at the point where the orbits intersect,—it plunges into our atmosphere and the friction of the rapidly passing air heats its surface to luminescence. Some of the molten material is brushed off by the air, thus forming the visible trail. The meteor or fireball will remain luminous until its material is spent, or until its velocity is reduced to a certain value.

*Fig. 1—The trail of a meteor in the constellation, Orion. This meteor travelled from left to right and exploded at x.—Yerkes Observatory.*

### METEORS, OR SHOOTING STARS

There is a great variation in the brightness of meteors and also considerable difference in color; the fastest moving meteors are bluish white while the slowest are reddish, with intervening colours according to their velocities.

When meteors first appear they are from 60 to 85 miles high and they fade out from 40 to 50 miles above the earth's surface. Their paths may be about 60 miles in length and their velocities range between 15 and 50 miles per second.

If the meteors on any given orbit be distributed uniformly on that orbit, there will be a "meteor shower" every year on certain days. If they be grouped, in a swarm, however, the showers will be a maximum periodically. There are several showers which occur annually and are given names according to the constellations of stars from which they appear to radiate, as follows:—

| Name | Constellation | Dates |
|---|---|---|
| Draconids | Draco | January 2 |
| Lyrids | Lyra | April 20 |
| Aquariids I | Aquarius | May 6 |
| Aquariids II | Aquarius | July 28 |
| Perseids | Perseus | August 12 |
| Orionids | Orion | October 20 |
| Leonids | Leo | November 14 |
| Andromedes | Andromeda | November 24 |
| Geminids | Gemini | December 10 |

The showers of Leonid meteors have been noticeably heavy at thirty-three year intervals. It is recorded of these meteors that, in 1833, "the sky was as full of them as it ever is of snowflakes in a storm" and that they "looked like a gigantic umbrella." There was also a heavy shower in 1866, but those in 1899 and 1932 were very light.

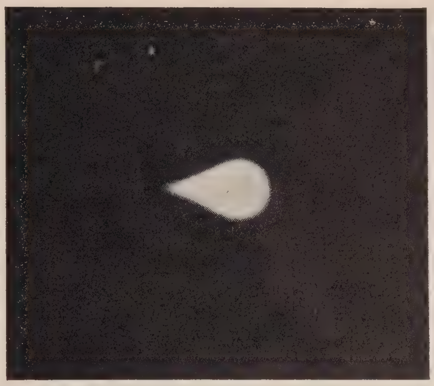


*Fig. 2—The fireball of April 12, 1938. The taper behind the head evidently is due to suction.*

### FIREBALLS, OR FALLING STARS

While there is no sharp line of division drawn between meteors and fireballs, the latter name is given to the larger bodies. They are usually the more brilliant and appear to travel more slowly.

As a rule, the head of a fireball is quite well defined and bright. It is rounded on the forward side and tapered toward the rear.

Two brilliant fireballs were observed by the writer in Toronto this year.

On April 12th, at about 7.30 p.m., a fireball, Fig. 2, travelled southward through the eastern sky, passing only a few degrees below the nearly-full moon. The trail was not visible owing to the brightness of the moonlight.

On June 5th, at about 9.50 p.m., a remarkable fireball was travelling northward in the southeastern sky. At first it appeared much the same as the previous one mentioned, the trail not being seen due to the slight haze existing. Then the head partly burst and three balls shot forward from it, Fig. 3. After travelling through

*Fig. 3—The celestial skyrocket of June 5, 1938. The head of this fireball shot out three smaller balls which preceded it through many degrees of travel.*

about ten degrees, two of these balls disappeared. The leading ball went nearly twenty degrees further and was moving much faster than the head. Both then faded out. It was a veritable celestial skyrocket.

Sometimes a fireball is seen to be particularly bright at several points along its orbit and finally to explode. Others have comparatively uniform trails and then merely disappear.

The trail of a fireball may often remain visible for a much longer period than that of a meteor. The writer recalls measuring the duration of one which could be seen clearly for forty seconds. Some are recorded as lasting for an hour.

### Meteorites

Fragments of fireballs, or all that remains of them, sometimes reach the earth's surface; these are known as "Meteorites." Many have been found and it has been observed that the heating in travel through the air has all occurred on the outside layers. Fireballs naturally are extremely cold,

*Fig. 4—The unique crystal structure of meteoric iron, known as "Widmanstatten" figures. This meteorite fell in Texas, U.S.A.*

—practically at "absolute zero," or 463 deg. below zero, fahr.—when they enter the earth's atmosphere. Their period of travel in the air evidently is so brief that the surface heat has not time to penetrate to the interior. There was one meteorite which fell into moist ground in India in 1860 which, when found only a half hour later, was actually coated with ice,—the surface heating in this case had been very slight.

Meteorites have been analysed chemically and about thirty elements have been found. These include, as the most common, iron, oxygen, nickel, silicon and magnesium,—and then to a lesser degree, sulphur, calcium, cobalt, aluminium, and sodium. Argon and helium also are present in small proportions.

There are three different types of meteorites, classified according to their composition,—

(a) Siderites,—composed of metallic iron with nickel and cobalt. These

have unique crystal structure not found in materials of the earth. Fig. 4.

(b) Siderolites, — being sponge metal with silicates filling the spaces.

(c) Aerolites,—stony meteorites, composed entirely of silicate minerals.

Judging by their structures, the iron meteorites must have cooled slowly while those consisting of stone have cooled very rapidly.

Meteorites are particularly interesting in that they present the only opportunities we have to examine closely and analyse, materials which have been formed outside the earth or its atmosphere. These analyses show the meteorites to contain elements that are found here in the earth and thus do they emphasize the consistency in composition in our solar system.—*F. K. D.*

# Accelerated Aging of Insulation of Rubber-Covered Wires and Cables

By J. R. Catterall, Testing Engineer, H.E.P.C. Laboratory

FOR more than twenty-five years, specifications for rubber-covered wires and cables have embodied certain requirements and test procedures designed to determine the quality and characteristics of the rubber compounds used for the insulation. These requirements may be divided into two groups,—

(a) Physical tests,—for elasticity, elongation and tensile strength.

(b) Chemical tests,—to analyze the rubber compounds and limit excessive use of injurious materials.

Physical tests on specimens of rubber insulation are simple; they require only a small amount of test equipment, consume very little time, and are comparatively inexpensive. Chemical analysis of the rubber insulation, however, is complicated; requires a fairly large amount of equipment, close supervision and the expenditure of considerable time; therefore is usually quite costly.

The experience of manufacturers of rubber-insulated wires and cables, also of inspection authorities who exercise control over the quality of certain types of insulated wires and flexible cords, has shown that rubber insulation will not retain its initial properties indefinitely but deteriorates more or less rapidly, at a rate depending upon the conditions of service to which the insulated wire is subjected and the nature of the ingredients used in the rubber compound.

With the discovery and application of organic accelerators,—(agents

which permit of lower sulphur ratios), —the first important step towards better aging quality of rubber insulation was taken. A rubber compound containing a fairly large ratio of such an accelerator is known to the trade as a super-aging rubber. Such a compound is a marked improvement over the ordinary type rubber compound, as the rate of deterioration is much lower.

*Super-aging Rubber*

Resistance to the action of oxygen is probably one of the most valuable features of those super-aging rubber compounds which are now used for insulation on some types of electrical conductors. It means longer preservation of the strength and elastic quality of the rubber, consequently greatly prolonged useful life. Wire insulation that lasts as long as the installation, rubber bands that do not break unexpectedly, long-life thread for all kinds of elastic garments, and rubberized fabrics that do not become stiff from deterioration are some of the advantages of super-aging rubber.

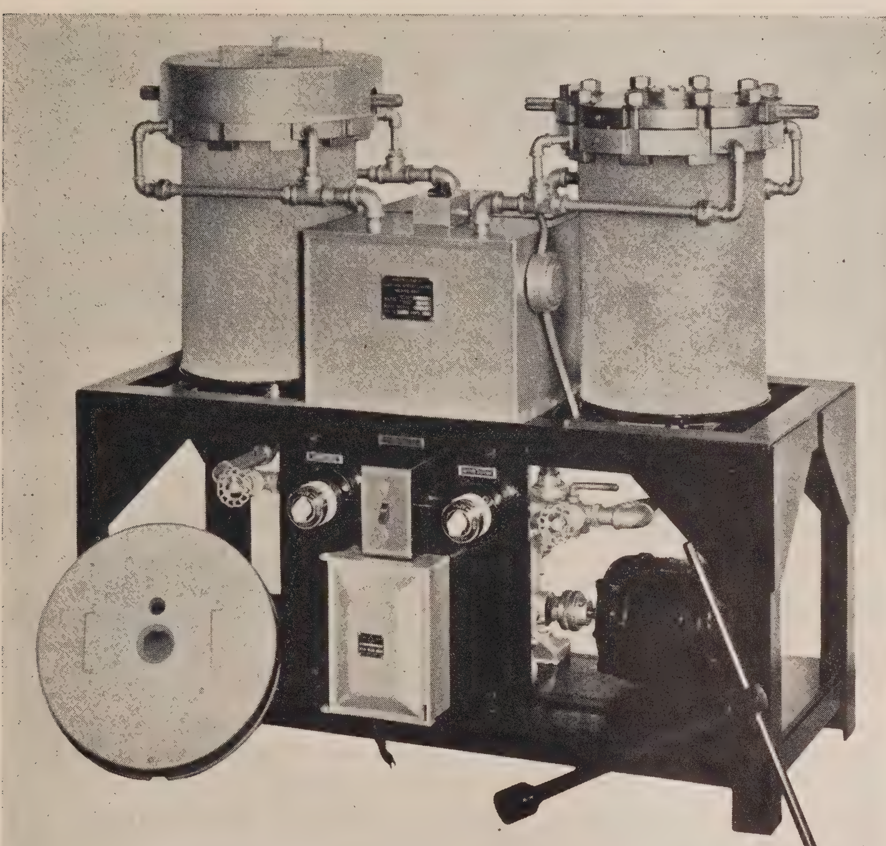
The introduction, into the commercial field, of aging and super-aging rubber goods has resulted in revisions to generally accepted specifications to include details of apparatus and test procedures to be followed in conducting accelerated aging tests on rubber, namely,—Specification D428-36-T of the American Society for Testing Materials and Specifications Nos. 36-31 and 36-33 of the Wire and Cable Section of the National Electrical Manufacturers Association. In 1935 Underwriters' Laboratories, Inc., of Chicago, revised its Standard for Rubber-Covered Wires and Cables to incorporate an accelerated aging test on what is termed "Code" rubber compound. Specification C22.2 No. 49 of the Canadian Electrical Code, Part II, issued by the Canadian Engineering Standards' Association also incorporates an aging test requirement in the case of Type POSJ flexible cord.

OXYGEN BOMB TEST

One of the most valuable aids to the rubber compounder yet developed is the "Oxygen Bomb" apparatus of Bierer & Davis. By its means samples of rubber, either for insulation or for other purposes, can be put through an accelerated aging test with a view to determining, approximately, how long the articles may be expected to remain in service before deterioration has become serious.

The oxygen bomb apparatus consists of a thickly-walled steel cylinder, with removable cover, in which specimens of rubber are exposed to pure oxygen gas at high pressure (usually 300 lb. per sq. in.) and at a slightly elevated temperature (usually 70 deg. cent.). Samples of rubber are suspended within the bomb, the cover bolted down tightly, and oxygen from a high-pressure cylinder injected into the bomb chamber until the desired pressure is attained. The temperature within the bomb is raised to the required point either by immersion of the bomb in a thermostatically-controlled water bath or by pumping heated oil from a reservoir through an outer jacket,—an integral part of one of the latest types of oxygen bombs.

Attempts have been made from time to time to correlate oxygen-bomb aging results with the amount of de-



Combination Bierer-Davis Oxygen and Air Aging Apparatus
with two Bombs 5" i. d. X 11" deep.

*Fig. 1—The air-oxygen bomb installed at the laboratory.*

terioration suffered by rubber goods in service or in storage. As several uncontrollable factors enter into the problem, however, it is difficult to predict very closely the service life of rubber from its behaviour in the oxygen bomb, but it is fairly generally accepted that an exposure of 12 to 24 hours in the bomb is equivalent to one year of shelf aging.

AIR BOMB TEST

Since an "oxygen bomb" test takes considerable time, a test known as the "air bomb" has been devised. In a recent paper before the New York Section, A.I.E.E., H. E. Thompson of the Anaconda Wire and Cable Company, stated that, on some types of compounds, this test reveals a depreciation in physical properties in five hours equivalent to that obtained in 21 days in the oxygen bomb. The new test uses air as the medium, under a pressure of 80 lb. per square inch and at a temperature of 260 deg. fahr. (127 deg. cent.).

The air bomb test is similar to the oxygen bomb test in that physical

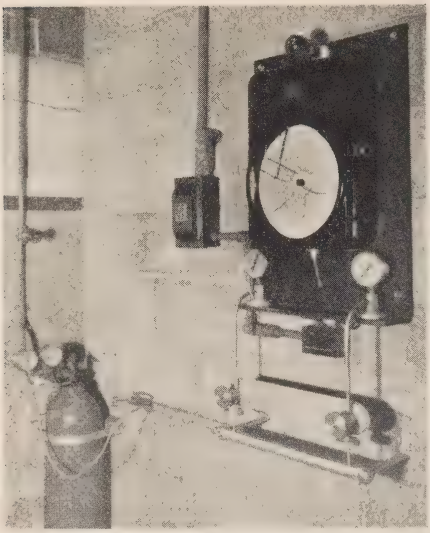


*Fig. 2—Control and temperature recording apparatus, placed outside the room for the safety of the operator.*

properties of aged specimens are compared with those of unaged specimens. Advantage lies in the speed and in the fact that a visiting inspector can witness the complete tests in one or two days; disadvantage is found in interpreting the tests in terms of operating life. Nevertheless, both types of accelerated aging tests give results that are definite, reproducible and of great significance to the rubber technologist.

AGING TEST EQUIPMENT AT H.E.P.C. LABORATORY

Within the last few months the Commission has installed combination air and oxygen bomb apparatus at the laboratory, so is equipped to conduct accelerated aging tests on moulded rubber lamp sockets, linesmen's gloves, etc. Also, the laboratory is now in a position to investigate, more thoroughly than heretofore, the quality of the rubber insulation used in the many types of wires submitted for approval and for listing as Standard. It is possible that as a result of the use of this new equipment future specifications prepared by the laboratory's engineers,—covering wires, cables and flexible cords,—and revisions to existing specifications may all include accelerated aging tests.

The air-oxygen bomb at the laboratory (Fig. 1), is located in the basement in a concrete-enclosed room which is locked to prevent entry by unauthorized persons while the bomb is under charge. Both the control and temperature recording apparatus (Fig. 2) are placed outside the room for the safety of the operator. In this way the Commission minimizes risk of injury to the employees, realizing that there is considerable potential danger in this equipment for, should an explosion occur as a result of a sudden combustion of the samples of rubber in the bomb, even the detonation of the safety valve, set at 500 lb., would have sufficient force to burst the eardrums of anyone in the room at the time.

# THE BULLETIN

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# Ragged Rapids Power Development Placed in Service

THE official opening of the Ragged Rapids Power Development on the Musquash river took place at 2.30 p.m. on Wednesday, October 26th, when the generating equipment was placed in operation by the Premier of the Province, the Honourable Mitchell F. Hepburn. Representatives of the various municipalities comprising the Georgian Bay system, as well as all three members of The Hydro-Electric Power Commission of Ontario, were present, together with various members of the engineering staff responsible for the design, construction, and operation of the plant. Prior to the official opening ceremonies about 200 guests of the Georgian Bay Municipal Electric Association and The Hydro-Electric Power Commission of Ontario attended a dinner in the Construction Department dining room located adjacent to the power house. After the dinner, the entire gathering repaired to the generator room of the power house where the opening ceremonies took place. John Kalte, President of the Georgian Bay Municipal Electric Association, acted as Master of Ceremonies. Brief addresses were made by Mr. Kalte and by J. Albert Smith, M.L.A., Dr. T. H. Hogg, and the Honourable W. L. Houck, M.L.A., Commissioner, Chairman and Vice-Chairman of the Commission respectively. Mr. Houck then introduced the Premier. After a brief address, Mr. Hepburn operated the governor control mechanism which started No. 2 generating unit, shortly after which this machine was connected to the Georgian Bay system transmission network and placed under load.

The Georgian Bay system derives its power supply from ten hydro-electric plants, three on the South Muskoka river with capacities aggregating 9,500 horsepower, two on the Severn river totalling 7,000 horsepower, one at Eugenia on the Beaver river with a capacity of 7,800 horsepower, and four small plants, two on the Saugeen and two at Bala, aggregating 1,500 horsepower. The total capacity of these ten plants is 25,800

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**Vol. XXV No. 10**
**OCTOBER, 1938**



***The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.***

horsepower. In addition, power is obtained from the Niagara system through the Hanover frequency changer set, which has a capacity of from 8,000 to 9,000 horsepower. The maximum system peak load during the past year was 35,500 horsepower.

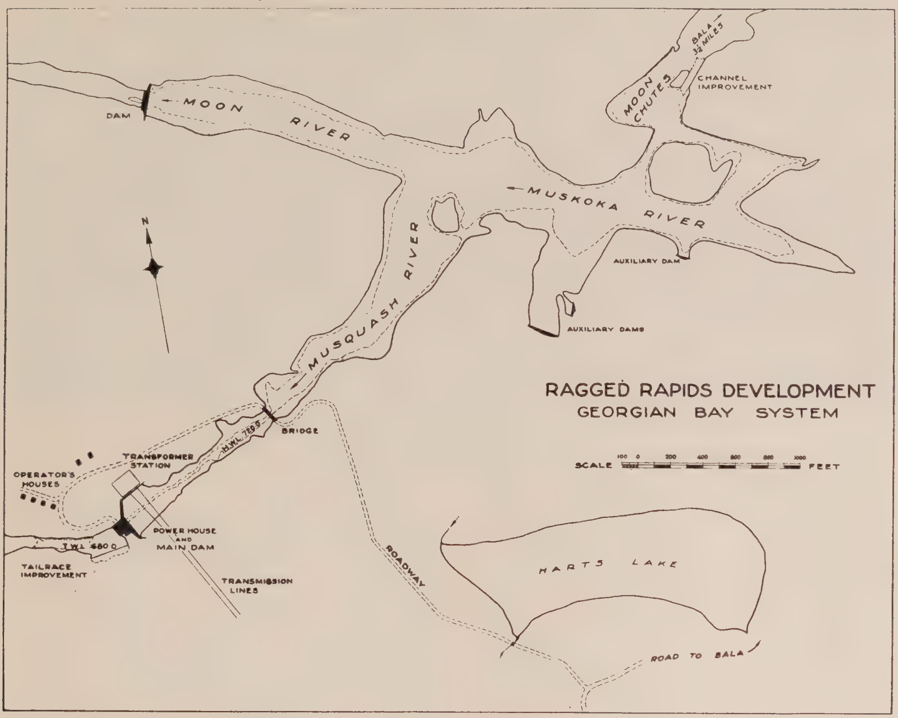
### Water Supply

The drainage area of the main branch of the Muskoka river at Moon Chutes, five miles below Bala, is 1,860 square miles. The water supply is derived from three principal sources, the south branch of the Muskoka river which drains the Lake of Bays area, the north branch which drains the area north and east of Huntsville, and the Muskoka Lakes area which includes lakes Joseph, Rosseau and Muskoka. The total drainage then discharges at the outlet of lake Muskoka at Bala, where the Provincial Department of Public Works maintains a regulating dam. A short distance below Moon Chutes the river forks into two branches, the Moon river discharging to the northwest, and the Musquash west, into Georgian bay.

Although the three Muskoka lakes and Lake of Bays are large natural storage basins, the outflow at Bala is subject to considerable variation due to the necessity of maintaining navigation levels, on these lakes. Upstream from Lake of Bays, however, the Commission controls 50,000 acre feet of storage in Hollow lake, and water from this reservoir can be used through the three plants on the South Muskoka river as well as in the plants at and downstream from Bala.

### Available Power

The total head between lake Muskoka and Georgian bay is approximately 160 feet, of which 20 feet occurs at Bala. Two small plants owned and operated by the Commission are located here, using only a part of the available flow. An examination of the topography of the Moon and Musquash rivers showed that the latter offered more favourable sites for power concentrations than the former. After development the Moon river will be available for the discharge of surplus flood flows. The scheme of development comprises four sites below Bala, with capacities totalling 35,000 horsepower. This, with 5,000 horsepower at Bala—the full capacity of




*General plan.*

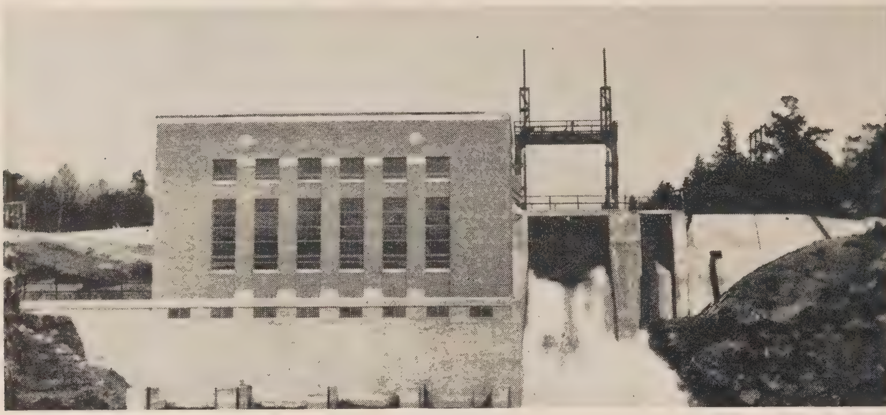
that site—will give a total of 40,000 horsepower on the river between lake Muskoka and Georgian bay.

## General Layout

The Ragged Rapids Development comprises a combined dam and power house located at the foot of Ragged rapids on the Musquash river, where formerly a thirty-foot drop occurred, and a diversion dam on the Moon river, a short distance below the forks. These structures flood out Moon Chutes, where a ten-foot fall existed. Three small dams were also required on the south bank near the forks to close off low areas. A forty-foot wide channel was excavated at upper Moon Chutes to reduce hydraulic losses in supplying water to the power house and to prevent natural levels being exceeded in the river below Bala during flood flows. A short tailrace channel carries the power house discharge to the pool below Ragged rapids. A roadway about one mile in length, was constructed from the existing road on the south side of the river to the power house site. A sixty-foot plate girder span was required to carry the roadway across the Musquash river at the head of Ragged rapids.

## Moon River Dam

The Moon River dam is a concrete structure, having a total length of 251 feet and a maximum height from foundation to deck of 26 feet. The central portion, 148 feet in length, contains eight sluices, each having a



*Down-stream view of power house and sluice gate.*

clear width of 14 feet, closed by stoplogs, for the operation of which a power driven spud-winch is provided. Bulkhead walls at either end of the sluiceway section have a combined length of 103 feet, the top width being three feet and the back batter 7½ to 12. Sufficient material was excavated under and opposite the sluiceway section to provide the same cross-sectional area as the river cross-section at the site before the dam was built, to assure free passage of flood waters.

### Main Dam

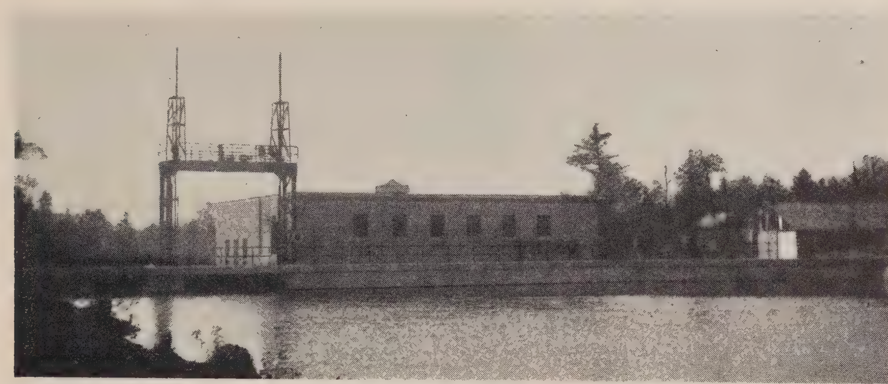
Adjoining the power house is a sluiceway opening twenty feet wide, with sill fifteen feet below normal water level, controlled by a motor-operated steel gate, which has been housed and electrically heated for winter operation. A log-slide intake is also provided. Bulkhead wing walls, with three-foot top width and 8 to 12 back batter, complete the main dam.

### Power House Substructure

The power house substructure is of the standard reinforced concrete type, with two intake openings for each unit containing steel racks and headgates. Spiral scroll cases and elbow draft tubes convey the water to and from the turbines. Air ducts are provided below the power house floor level to supply cooling air to the generators. The overall length from the face of the intake to the end of the draft tubes is 90 feet, and the width 73 feet. Centre lines of units are 35 feet apart.

### Hydraulic Equipment

Because of the considerable variation in river flow, automatically adjustable blade runners were installed. The turbines supplied are rated at 5,200 horsepower under 38 feet of head, and operate at 200 rev. per min. The five-blade, fully machined Kaplan runners are expected to give high efficiencies over a wide range in load and discharge. The servomotor controlling the adjustable blades of the turbine runner is located in the turbine shaft. Oil pressure governors are used to control the units with pressure and sump tank interconnected.



*Up-stream view of power house.*

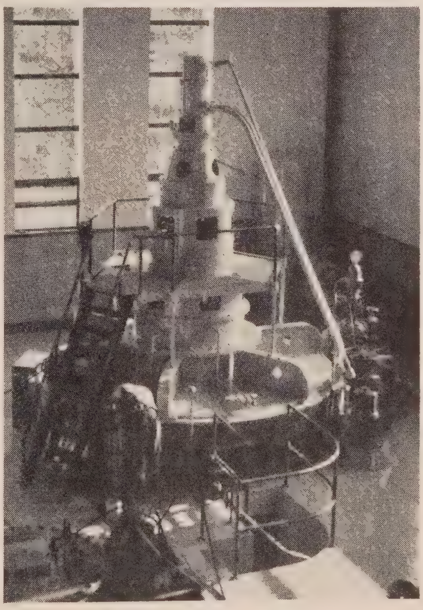
### Power House Superstructure

The power house superstructure is of structural steel, brick and tile construction. The roof area is 73 feet by 65 feet. There are three galleries on the upstream side of the generator room. On the lower gallery are located the control room, water pumps and station service transformers. On the second gallery are the battery room, storage room for spare generator coils and parts, work shop, battery charging motor-generator set and domestic water chlorinator. The top gallery contains the 6600-volt metal-clad switchgear and the headgate hoists. A 25-ton motor-operated crane is provided in the generator room.

### Generators

The two vertical generators are each rated at 4500 kv-a., 85 per cent power factor, 6600 volts, 200 rev. per min. 60 cycles, and have 70 kw., 125-volt main exciters and 4 kw., 125-volt pilot exciters direct connected thereto. Mounted above the pilot exciter is the "oil head" for the servomoter, located in the turbine shaft at the coupling, which operates the adjustable blades of the turbine runner.

The main field air circuit breakers are mounted on the exciter panels, which are located near their respective units. The main exciter field rheostats are motor-operated and are mounted adjacent to their respective exciter panels.



*No. 2 generating unit.*

*Operators' cottages.*

LOW VOLTAGE SWITCHING EQUIPMENT

The 6600-volt switching equipment is all contained in a metal-clad switchgear structure located on the top gallery. A circuit breaker may be isolated by racking down with the worm gear mechanism in its compartment. This mechanism is mechanically interlocked to trip the breaker should it not have been opened before starting to rack it down or up. The potential transformers are mounted in filing cabinet type drawers, an individual transformer and fuse unit being contained in each drawer. Opening the drawer disconnects the transformer on both primary and secondary sides. A truck and "test rack" provide facilities for withdrawing a breaker from its compartment and mounting for inspection. The test rack is equipped with control facilities for operating a breaker. A grounding device may be substituted for a breaker in a feeder compartment and racked into position to ground the feeder.

MAIN SWITCHBOARD

The main switchboard, located in the control room, has eleven panels and a swing panel. On this board are mounted all the indicating and graphic meters, the relays, rheostatic voltage regulators, generators temperature indicators, ground detectors and annunciators. Also in the control room, but separate from the main switchboard, is a panel for control and indication of the battery charging equipment. Space is left in the control room for installation of remote control equipment for future plants on the river.

TRANSFORMERS AND 38-KV. SWITCHING EQUIPMENT

The transformers and 38-kv. switching equipment are located 300 feet to the north of the power house. The switching structures are of galvanized steel. A transfer track and truck provide facilities for moving a transformer to an erection building, where the core may be lifted by a

chain block. The main bank comprises three 3,000 kv-a., self-cooled transformers. The voltage ratio of the bank is 6600 volts delta to 38,000 volts star. A spare transformer is supplied.

### Operators' Houses

There are six operators' houses of the semi-bungalow type, each having six rooms. These houses are provided with electric service, chlorinated water and septic-tank sewage systems.

### Construction

Construction of the development was commenced in May, 1937. It was evident that water transportation from Bala to the site would be very desirable. Accordingly two temporary timber dams were built to drown out Moon Chutes. The first of these, having five sluiceways, was on the Moon river above the site of the Moon river dam and served as an unwatering dam. The second was on the Musquash river at the head of Ragged rapids. At the same time the excavation at upper Moon Chutes was proceeded with to provide navigable velocities there. A siding was constructed at Bala with a derrick and special unloading facilities for handling sand, stone and cement direct from the cars to scows. By the middle of August these facilities were complete, and the delivery of concrete aggregate began.

Power house excavation was carried out in the dry, as the river flow was confined to the Moon river. The main dam and the power house substructure were completed early in April, and the sluice gate was opened to pass water for log-driving on the lower reaches of the Musquash river. Work on the Moon river dam proceeded progressively across the river. An exceptionally high fall flow in the river necessitated suspension of work on this dam during November and December, but it was completed in March before the spring freshet.

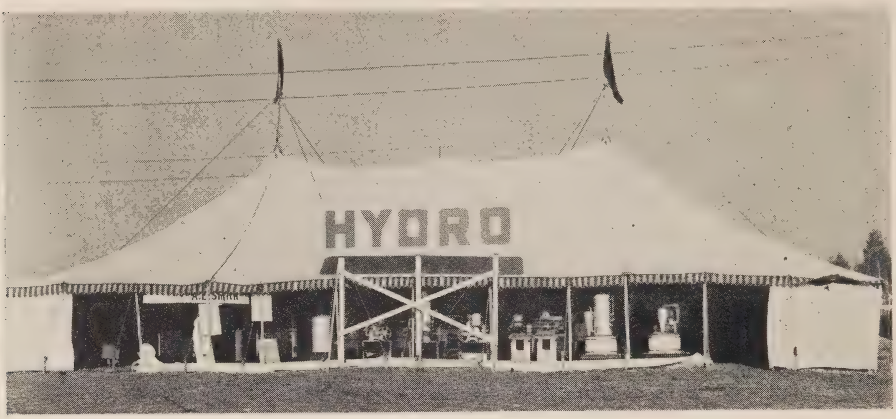
At the power house and the Moon River dam, concrete was placed with a "pumpcrete" machine, which takes the concrete from the mixer and delivers it through a steel pipe to the forms.

The principal quantities involved in the construction of the development were:

| | |
|---|---|
| Cofferdams | 4,800 cu. yd. |
| Rock Excavation | 13,500 cu. yd. |
| Concrete | 9,900 cu. yd. |
| Transportation | 26,500 tons |

The Ragged Rapids plant is the first the Commission has constructed in which Kaplan runners are installed, and its operation will therefore be watched with considerable interest. With the system load at 35,000 horsepower, this plant will operate at capacity from the time of its completion, the Hanover frequency changer set being available as a standby and to supply energy during times of low water supply.

The plant was designed and constructed by the Commission's staff. Turbines and governors were supplied by the S. Morgan Smith-Inglis Company; generators by the Canadian Westinghouse Company; low-voltage switching, switchboard and accessories by the Canadian General Electric Company; and the main transformers by the Hackbridge Transformer Company of Canada.




*Hydro display at the plowing match.*

# The International Plowing Match

THE twenty-fifth international plowing match and farm machinery demonstration of the Ontario Plowman's Association was held this year on Oct. 11th to 14th on the Minesing flats, near the village of Minesing, in Simcoe County, and was favored with typical Indian summer weather with the exception of one rainy day.

On Thursday, the match was honored by a visit of His Excellency, Lord Tweedsmuir, Governor General of Canada, who showed a keen interest in the contests and the work of the Ontaro Plowmen's Association. A record crowd turned out, in spite of the rain, to greet His Excellency.

The match established new records in many respects. There were 588 entries in the various competitions, and exclusive of caterers, there were 65 exhibits. The attendance was estimated at approximately 120,000. The concession area was laid out in the form of a quadrangle in an 18-acre field, the total frontage of the concesson lots being in excess of 4,000 feet, which was approximately 1,000 feet more than at previous matches.

The distribution system supplying the grounds necessitated erection of approximately 2,800 feet of three-wire secondary bus, which was supplied by two 15-kilowatt transformers, providing 57 services to concessionaires and eleven street lights.

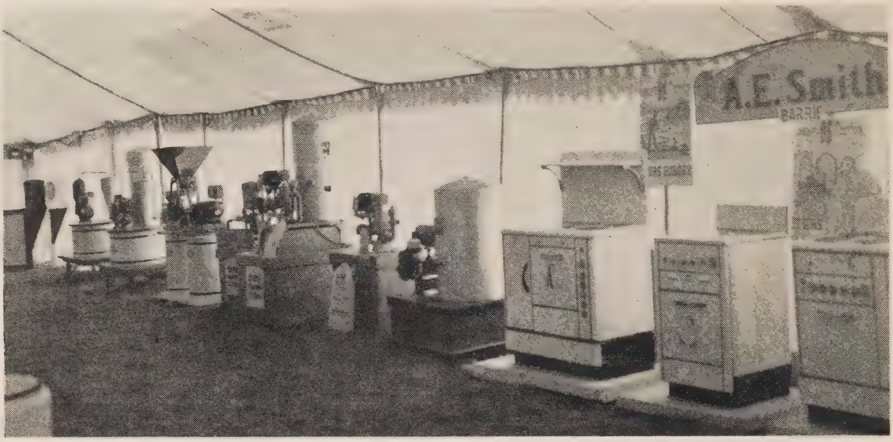
The water system consisted of approximately 2,500 feet of two-inch water main supplying twelve hydrants located at convenient points throughout the grounds. The water was pumped from a driven well by a shallow-well pump into two large storage tanks providing approximately 1,000 gallons capacity. Tests on the well in-


*Exhibit of washing machines and other household equipment.*

dicated it would stand pumping at a rate of approximately 310 gallons per hour continuously. The total water requirements for the match varied from 2,500 to 4,000 gallons per day.

The Commission's demonstration was housed in a tent 40 feet by 70 feet, and consisted of a representative display of electrical household equipment including a complete line of electric ranges, washing machines, ironers, refrigerators, radios and other small appliances. One portion of the tent was devoted to farm equipment including grain grinders, milk coolers, milking machines, cream


*Electric ranges and refrigerators.*




*Electric grain grinders, water pumps and further ranges.*

separators and a full line of automatic water pumping systems, together with a display of motors and wiring devices. The equipment displayed was loaned by manufacturers who had representatives present to give complete information. Also members of the Commission's staff were in attendance to give information on rural electric service. The display attracted large crowds of interested visitors throughout the match, the manufacturers' representatives reporting that a large number of keenly interested prospects were obtained and numerous sales were made. The interest in household equipment was chiefly in washing machines, ranges and refrigerators, while in the farm equipment, the grain grinders and milk coolers attracted the greatest attention.

The Commission's prize consisting of a half-horsepower motor as first prize in class 6 tractor plowing, was won by Russell Hare of Nanticoke, Haldimand County. Mr. Hare had the unique distinction of winning three first prizes in tractor plowing.

The second prize in this class has been provided by the Ontario Plowmen's Association and designated the J. W. Purcell Memorial Trophy in recognition of the esteem in which the late Mr. Purcell was held by those connected with the Association, of which he was the Honorary Director, and of the services rendered by him to the Association during the long period he was connected with the Commission in the development of rural electrification.

The match concluded with a banquet provided by Simcoe County, at which approximately one thousand attended.

The Plowmen's Association and the local committees are to be congratulated on the intense interest and remarkable growth which has developed in this annual affair.

# Hydro Service to Gold Mines and Mining Areas Generally in Northern Ontario

By A. E. Davison, Transmission Engineer, Electrical Engineering Dept., H.E.P.C. of Ont.

THE Government of the Province of Ontario, using The Hydro-Electric Power Commission as agents, commenced to distribute power to the mining areas of Northern Ontario in 1930. Development of these areas has been rapid, with the result that mining is of major importance in the economy of the Province of Ontario.

From the Province of Ontario's Gold Bulletin for July, 1938, we find that gold production is at a rate just under $107,000,000 per year, the result of the milling of slightly less than 10,000,000 tons of ore, which is an increase of 12 per cent when compared with July, 1937. Reports for the year 1937 indicate that the value of metals, other than gold, mined in Ontario in 1938 will be about another $100,000,000.

The significance of these figures is not easily comprehended. It has been said, of the Sudbury area, for instance, that the value of the gross annual production of metals in that small area of practically one community has in some years exceeded the annual income of some provinces.

This Ontario income of $200,000,000 per year (Ontario reports a 230 million dollar mineral industry for 1937) is the result of effort and work within a few comparatively small communities, totalling say 80,000 to 100,000 people. It has an important effect upon the standard of living and the comfort of all people in Ontario. It has as well a measurable effect upon the trend and volume of business done by every citizen of the Dominion of Canada. Specific references to the immense growth of mineral production in the Dominion as a whole were made by Dr. Hogg in the January, 1937, issue of *The Bulletin.* In that article it is pointed out that the total value of mineral production in Canada has grown from around $22,000,000 in 1896 to $310,000,000 in 1935. According to summaries made by the Royal Bank of Canada, the value of Canadian mineral production is now almost $500,000,000 per year.

Another way to visualize this development is to compare growth in power consumption out of Abitibi Canyon development, which commenced operation in 1933, with the municipal load of the Niagara system. The Canyon load for 1938 is some five years later, of the order of 160,000 horsepower. The municipal load of the Niagara system, commencing in November, 1910, with less than 2,000 horsepower, reached the equivalent of the present output at the Canyon

during 1919, nine years after initial purchase of power. Over 100 municipalities were being served in 1919.

The effect of the activities of these mining communities, developing rapidly during a depression and throughout an almost unbroken series of relatively poor agricultural years, may never be entirely comprehended. For instance, the payroll of the mineral industry of Ontario alone amounted to $43,500,000 for the year 1937 to some 25,000 employees. Nearly all this money is put back into circulation immediately, much of it ultimately reaching the Canadian producer of foodstuffs and of clothing materials. Government reports indicate that another $55,000,000 is paid out for supplies, including electric power.

As previously mentioned in this article, the H.E.P.C. entered this field in 1930 and has not lagged in facilitating this development wherever possible. Of the producing gold mines in Ontario, approaching fifty in number, practically 70 per cent are now served by the Hydro-Electric Power Commission in varying quantities, sometimes exceeding 4,000 horsepower for a single customer. A total of some 45 gold mining projects are now being served, as well as three nickel mines. It is interesting to note that the Hydro Commission supplies, in round figures, 30 per cent of the producing mines of the Kirkland Lake—Larder Lake area, and in the Kirkland Lake area a larger block of energy which is not included in this percentage is sold to the Canada Northern Power Corporation Limited for distribution. The Commission also serves approximately 90 per cent of the mines of the Thunder Bay area. The growth in the use of Hydro power by the mining industry has been rapid as well as large, since, as has been previously stated, the Commission entered this field only eight years ago.

A description by T. C. James, of the power sources supplying the various mining districts, has already appeared in the October, 1936, issue of *The Bulletin.* In that article it was pointed out that power consumption for mining purposes was of the order of 65,000 horsepower. In two years this consumption has grown to 120,000 horsepower, an increase of about 85 per cent. Of this, some 95,000 horsepower is produced by the Abitibi Canyon development.

The distribution of this power calls for a considerable network of transmission lines. Lines either built or purchased by The Hydro-Electric Power Commission, and used wholly or in part in serving the mining industry, have steadily grown since 1930 to over 1,226 miles at the present time.

Some of these networks are quite large and the routes quite long, as in the Abitibi district. One of these is a double-circuit tower line supplying power to Copper Cliff, running generally north to south for a distance of some 246 miles. Other lines from the Abitibi Canyon plant reach Kirkland Lake, Larder Lake and Matachewan via Iroquois Falls and as well extend westward from Hunta to Smooth Rock Falls. The total length of the high voltage lines now serving power out of the Canyon is 553 miles. In addition to these higher voltage lines, there are some 54 miles of feeders

operating at 13,200 and 26,400 volts.

In the Thunder Bay area, the transmission system has considerable coverage. The 110 kv. lines extend from Little Long Lac mining area through the generating stations on the Nipigon River to West Fort William, a distance of over 175 miles.

In order to provide the reader with a better idea of the physical conditions at those mines served by Hydro, a number of illustrations accompany this article. An attempt has been made in these photographs to have the comparatively inconspicuous, but nevertheless very important, power station appear in the foreground. Complete photographic records have not been collected; however, an attempt has been made to include some of the more typical photographs available to the Commission. From time to time views of other producing and promising properties may appear.

Mining works change their whole appearance almost over night. The result is that a few of these records, faithful to the conditions at the time the photograph was taken only a few months ago, may be scarcely recognizable to the local operators today. Many of the photographs were taken in Winter and present a familiar but not altogether typical landscape. In general the pictures have been grouped into districts. For example, the double page (centre) records those mines in the Porcupine area which are supplied with Hydro power. A number of these have recently become producers.

This Porcupine camp is one in which some of the larger and older Canadian producers are located. That its possibilities are not exhausted is shown by the fact that during the past two years at least four new producers have been supplied with power by the Commission. Hydro-electric power was first distributed in the camp in 1935.

The Kirkland Lake—Larder Lake areas are also among the older camps. Power is supplied in this area from two high-voltage stations, one in each area. Each station has its network of lower voltage feeders. There are now some eight different gold mining properties in this district, of which 50 per cent are producing, which are receiving Hydro power.

A high-tension line from Kirkland Lake extends to the Matachewan area where there is a high-voltage station, and lower voltage feeders supply mines in this district.

Photographs of a group of six of the mines in the Long Lac district appear on pages 338 and 339. These comparatively new camps are now being reported by the Department of Mines of Ontario, and include such important producers as Little Long Lac and Northern Empire mines. Service was first given this area in 1933. The output for this camp of eleven producers is already an important item in the Ontario Producers' list. Production for July was at the rate of $7,500,000 per year, and milling was at the rate of 600,000 tons per year.

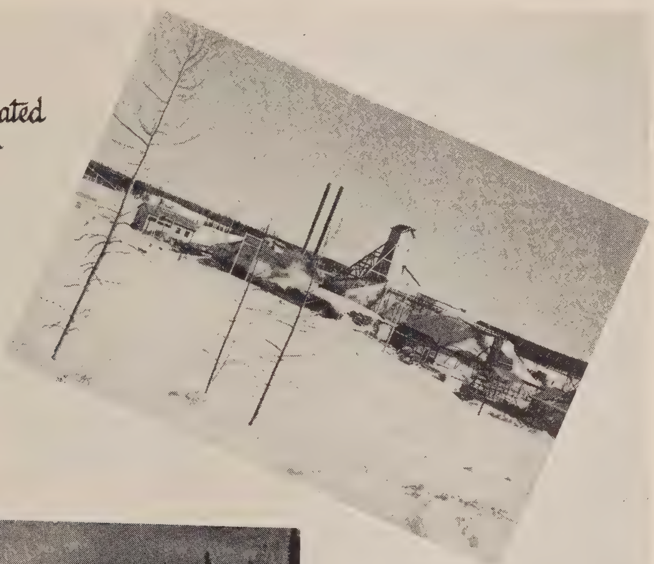
The photographic and montage work has been arranged by Ross Lemire of the Hydro staff.

The Sand River Gold Mines Co. Limited.

Little Long Lac Gold Mines Limited.

Hard Rock Gold Mines Ltd.

Bankfield Consolidated Mines Limited.



Northern Empire Mines Co. Ltd. (Beardmore).

The Leitch Gold Mines Ltd.

Hallnor Mines Limited.

Buffalo-Ankerite Gold Mines Limited

Kerr-Addison Gold Mines Ltd.

· Pamour-Po

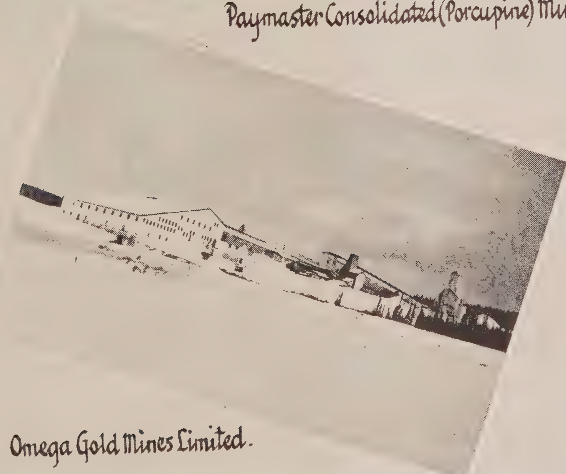
· Bidgood-Kirkla

Hollinger Consolidated
Gold Mines Limited.
(Hislop Twp)

ines Limited.

Paymaster Consolidated (Porcupine) Mines Ltd.

Mines Limited.



Omega Gold Mines Limited.

# The Eastern Ontario System

By Dr. Thomas H. Hogg

DURING the comparatively brief period of less than a year that has elapsed since I became Chairman, the pressure of many new and time-consuming matters has deprived me of the opportunity to meet as many of the officers and members of our local associations as would have been my desire. It is, therefore, a special pleasure to be here today not only to discuss with you in a more or less informal way problems of common interest, but also to have the added pleasure of meeting new acquaintances, and I hope making new friends.

Today's gathering affords an opportunity to review past progress and present plans, and while this is worth while in itself the opportunity to meet a larger circle of the members of your association and learn at first hand something more of the problems which engage your attention is to me not only more interesting but also more important.

The Eastern Ontario system of The Hydro-Electric Power Commission of Ontario is second only to the Niagara system in extent of territory served,* in power utilized, and in number of customers. As you know, it is the product of the amalgamation of several smaller systems—the Central Ontario and Trent, the Rideau, the St. Lawrence, the Ottawa, and the Madawaska. These systems constituted fairly satisfactory units so long as power supplies obtainable locally were sufficient for their respective needs. When, however, the growth in load became such that local power supplies were no longer adequate, the disadvantages of maintaining small separate units became more apparent and serious. Larger sources of power outside of the various districts had to be tapped as a common supply. This required more complete interconnection between the several districts which had the further advantage of furnishing each district with greater security against breakdown of any kind; in other words, with a greater standby of power reserve. Amalgamation of the smaller districts into a large unit was the only thoroughly effective means of securing these advantages for all the districts in the most economical way.

### Power Supplies

As many of you know, the problem of securing ample power supplies for the smaller systems now incorporated in the Eastern Ontario system, was at times a very acute one. Provisions made since amalgamation have solved this problem and I am sure that it is a matter of satisfaction for you, as it is for me, that present and future power requirements are adequately safeguarded.

From the viewpoint of reliability of service the disadvantages of having

Address to Eastern Ontario Municipal Electric Association at Belleville, October 12, 1938.

* The total area is greater, but a large part of it is sparsely populated and not yet reached by transmission lines.

too many eggs in one basket are well recognized. A number of sources of power supply in widely separated localities are less likely to be simultaneously affected than is a single source of the same aggregate capacity. In this respect, the Eastern Ontario system is especially favored for its power supplies come from no less than seventeen developments owned and operated by the Commission; these are supplemented by purchased power from four different sources and by standby power available by transfer from the Niagara system. These sources of generated, purchased and transferred power are widely distributed with regard to the territory served. To obtain the fullest possible benefit from these widely distributed sources of supply, they must feed into a transmission system which is reliable in operation and provided with interconnecting trunk lines so located that the failure of one transmission line will not interfere with the continued delivery of the primary requirements of any district. A thoroughly co-ordinated transmission system equipped with modern relay and protective devices is very necessary.

Much has already been accomplished in the direction of highly reliable interconnection for the Eastern Ontario system and more is under consideration; among the more recent additions are the Madawaska tie in the form of a 33,000-volt transmission line from Carleton Place to Arnprior, and the 110,000-volt Chats Falls-Trenton line.

The Madawaska tie has been very valuable in two ways:

1st—It has made available to the system as a whole the surplus capacity in the Calabogie plant over and above the requirements of the Madawaska district.

2nd—It has enabled the system to come to the aid of the Madawaska district for a period of four months this year, during which the Calabogie station was disabled owing to the damage of generators by lightning. But for this assistance which the system was able to give, the Madawaska district would have been seriously short of power.

The value of the Chats Falls-Trenton line will be evident from some later remarks relative to the frequency-changer at Chats Falls and its relation to the operation of the Eastern Ontario system.

It is quite probable that the next trunk tie will be a 110,000-volt line between Ottawa and Chats Falls, which will greatly strengthen the interconnection between the Central Ontario district on the one hand and the Ottawa, Rideau, Madawaska and St. Lawrence districts on the other.

It is not my intention to give you in this brief talk detailed figures respecting the system's progress. What I have to say is of a more general character, but it will serve to show that the system has made and is making a sound economic growth. During the worst years of the depression, 1930 to 1933, the maximum yearly peak of the primary load fluctuated between about 90,000 and 94,000 horsepower, but in the four years, 1934 to 1937 inclusive, it increased from about 92,000 horsepower to 125,000 horsepower, an increase of 36 per cent. For these four years, there-

fore, the average annual growth in primary peak load exceeded 8,000 horsepower.

About the time of the amalgamation of the earlier systems to form the Eastern Ontario system, and just before the depression, the Commission entered into a contract with the Gatineau Power Company for a supply of 60,000 horsepower to be taken in annual increments of 6,000 horsepower. As you know several revisions have been made in this contract, and in accordance with the revised terms the Commission had only taken 42,000 of the 60,000 horsepower up to September 30th. Since October 1st the remaining block of 18,000 horsepower has been accepted under the contract and is being used as required.

Under the Gatineau contract, the Commission has secured for the Eastern Ontario system a very economical supply of power. For a number of years it has been the main source upon which the Commission has drawn to meet growth in load in the Eastern Ontario system. In addition, however, the Commission has made changes in certain of its plants and has purchased from the Canada Cement Company three small power developments on the Otonabee River, north of Peterboro, and two from the Quinte and Trent Valley Power Company.

The Commission received dual value with the acquisition of these plants; they are not only valuable developments in themselves but they are of even greater importance through the control of the regulation of river flow which they have enabled the Commission to exercise. This flow control, in conjunction with an agreement with the Department of Transport, has greatly enhanced the value of the Commission's major developments on the Trent and Otonabee Rivers.

Although these additional power supplies have provided ample capacity to meet growth requirements up to the present time, for the past year there was very little excess capacity from our generating plants and purchased power contracts during the maximum peak load period. It is estimated that the 18,000 horsepower which is now being taken will provide adequate power for the next two years, although the margin of reserve would be relatively small were it not for the standby service provided by the Chats Falls frequency-changer and the interconnecting 110,000-volt line. A comparison of the maximum normal capacity of the generating plants and purchased power contracts available to the Eastern Ontario system shows that the Commission has available to meet the requirements of the system during the present winter peak 152,000 horsepower; whereas the anticipated maximum primary load in 1938 is estimated to be about 136,000 horsepower.

As you know, there were included in the purchase of the Madawaska properties, in 1930, rights to develop power sites on the Madawaska river. These power sites are eight in number with an estimated capacity of 140,000 horsepower, and in size and location afford a favorable opportunity for developing, step by step, low-cost power for the Eastern Ontario system; each development being ample to meet normal growth but not in excess of probable requirements at any one time.

You are, of course, well aware that the total "cost of power" to the Eastern Ontario system includes interest charges on money paid for these sites, which at present stand on the Commission's books at $650,000. The Commission has maintained that payments to sinking fund should be deferred until the sites are put to beneficial use.

As the matter now stands, the surveys for the greater portion of the river have been completed. The first and most favorable site is at High Falls where an initial development of 18,000 horsepower can be made without storage; with storage the capacity can be doubled.

### Recent Growth

Although the Eastern Ontario system was formed in 1929 by the amalgamation of the St. Lawrence, Rideau and Central Ontario and Trent systems, it was not until the following year that an act respecting the Central Ontario Power system was passed formally vesting in the Commission the properties of the Central Ontario system as it existed on November 1, 1928. In 1930, the Ottawa and Madawaska systems also became parties to this amalgamation. For the system as a whole, therefore, it is not feasible to go back further than 1930 for comparative figures and even in going back that far certain changes that have since taken place have to be remembered.

By 1930, as you know, the depression was upon us and the normal growth of the whole Hydro undertaking slackened materially. Between 1930 and 1937 eleven urban municipalities, including the towns of Bowmanville, Cobourg, Deseronto, Trenton and Tweed, became partners in the Eastern Ontario system. While about ten per cent of the present consumers of the system reside in these places, it is noteworthy that in most cases, their entry into the partnership had no effect upon the system load for the consumers of most of these municipalities had been retail customers of the Commission before the municipalities took over the distribution of power on the standard Hydro basis.

This comment also applies to certain other municipalities which joined the Eastern Ontario system prior to 1930; these include the cities of Belleville and Oshawa, and the towns of Brighton, Lindsay, Napanee and Port Hope; but the records for these municipalities are, of course, included in the comparison for the year 1930. During the past year other municipalities have joined the partnership, among them Kingston and Morrisburg, and it will be of interest to you to know that the few remaining urban municipalities that are not on a cost basis have been negotiating with the Commission with a view to purchasing the local distribution systems and entering into full partnership.

### Capital Investment

Between 1930 and 1937 the recorded net growth in the capital investment of the Commission in the Eastern Ontario system was relatively small. The effects of the depression, with its resulting diminution in load growth and the provision of future load requirements by purchase, made extensive investments unnecessary. But the recorded figure of net growth does not

tell the whole story; the situation has been complicated by such things as the transfer of the Nipissing district to the Northern Ontario Properties, the sale of local distribution networks to urban municipalities coming into partnership—in effect a transfer of capital from the wholesale to the retail operations—and certain adjustments respecting properties acquired in the purchase of the Electric Power Company's assets. In the main, additional capital expenditures during the period have been for trunk transmission lines and transformer stations linking up the several districts with the new sources of bulk power supply and with each other, and for rural extensions. There was, of course, a substantial increase in capital investment in 1930 due to the purchase of the Madawaska properties, and again in 1937 due to the purchase of the additional power developments on the Trent and Otonabee rivers, already referred to.

### INCREASE IN RESERVES

In the financial reserves of the system there has been a noteworthy increase from less than 4¼ millions in 1930 to nearly 8½ millions in 1937, or more than 100 per cent. These figures relate, of course, to the wholesale or co-operative undertaking administered by the Commission for the Eastern Ontario system municipalities, and they speak well for the splendid way in which the Eastern Ontario system has weathered the depression and subsequently embarked upon a vigorous forward movement.

As you know, there is included in the cost of power to the municipalities payments on account of sinking fund. By these payments the partnership municipalities acquire year by year a larger equity in the co-operative plant. During the seven-year period mentioned the equity thus acquired by the municipal partners of the Eastern Ontario system increased from less than half a million dollars to nearly 1¾ millions of dollars; actually an increase of about 300 per cent. The equity of Belleville, for example, increased from $22,000 to $120,000.

The local municipal utilities have had an equally satisfactory record. The total assets have increased during the past seven years by 44 per cent, from 8 2/3 millions of dollars to 12½ millions of dollars. The total liabilities, on the other hand, have decreased by more than 30 per cent, from rather more than 3¼ millions of dollars to 2¼ millions of dollars. The local reserves and surplus have increased from less than 5 millions of dollars to 8½ millions of dollars, or by more than 70 per cent. In considering these and other figures, the effect of adding new municipalities during the period must be remembered.

### STABILIZATION OF RATES RESERVE

I should like to make a brief public reference to a few matters of general interest that have been discussed from time to time with delegations from your association. The first of these matters is the question of the establishment of a stabilization of rates fund. This I believe to be a very important matter, and while I do not intend to discuss it in detail, my general views may be of interest to you.

In the financial operations of *privately-owned* utilities the variations

between revenues and costs throughout an industrial cycle of prosperity and depression are, to a considerable extent at least, taken up by differences in profits and dividends. In a *publicly-owned* enterprise operating on the basis of service at cost, no corresponding leeway exists and it is therefore desirable, indeed necessary, to set aside in good times, sums for the equalization of the wholesale costs of power over a period of years, and for the stabilization of rates to consumers.

Aside from the effects of alternating cycles of prosperity and depression and even in times of normal growth in load and revenue there may be variations in the cost of power due to a number of causes. From time to time the growing needs of a system require the development or purchase of additional power supplies. Whether these additional supplies are secured from development or purchase, definite financial commitments must be made in advance of needs. Under these conditions even if the system load does grow as expected the new commitments may be of such magnitude as to cause a temporary rise in the cost of power actually used. Although these fluctuating costs of power cannot altogether be avoided, it is obviously undesirable to have them immediately reflected in fluctuating rates to customers for electrical service. Fluctuating rates create a sense of uncertainty and tend to frighten away potential users. It is to iron out these differences in costs and maintain uniform rates over a period of years that the fund for the stabilization of rates is created.

I should like here to add a few additional comments as to the effect of depression periods on the financial operating record of the Commission, more particularly with respect to the *interim rate*, which is really an estimated rate based upon a forecast for the year ahead of probable load and total system costs. The total system costs can be estimated with a considerable degree of accuracy but the load estimate may be upset completely by economic factors quite outside the control of the Commission. When depressed times affect the Commission the revenues from the large industrial system customers decrease and the number of horsepower sold also becomes less. At the same time the horsepower demand of the municipalities will fall below expectations for which power supplies have been provided. Consequently the total cost of power, which obviously cannot be reduced in proportion to the reduced demand, has to be divided by the smaller number of horsepower supplied to the companies and to the municipalities to obtain the *average cost per horsepower* utilized. It is clear, therefore, that in depressed times the average cost per horsepower tends to become higher, and in prosperous times the reverse is true; also that the *interim rate* to the municipalities is, as a rule, affected to a greater degree by changes in demand than by changes in the total cost of operating the system.

I make this word of explanation because it is not always understood that in times of economic depression, *unless the situation is rectified by the utilization of a previously accumulated stabilization fund,* the actual *average*

*cost per horsepower*, and therefore *the interim rate*, tends to increase, just when revenues are decreasing and a stabilized rate is most desirable.

During the spring of 1937, at a time when loads and revenues were growing, the Commission then in office approved of a flat reduction in the interim rate chargeable to all cost towns in the Eastern Ontario system. As this reduction of $3.00 per horsepower took effect on August 1st, 1937, it was effective for only three months during the last fiscal year. This year the Commission has felt the full effect of this rate reduction, and it is doubtful whether it will be advantageous to set aside any substantial sum in the fund for the stabilization of rates.

As to the desirability of a stabilization of rates fund there can be no question. The amount that should be set up from year to year and the magnitude of the fund that should be accumulated and maintained is a matter for judgment about which there is room for differences of opinion, but as to the principle itself there can be no difference of opinion.

I have already pointed out that comparatively little net increase has taken place in the capital investment in the system during the past seven years. With the exception of the ordinary normal capital expenditures which will be required for enlarging transformer stations at various points to take care of normal growth, and for the extension of rural lines, the only capital expenditure of magnitude which is under consideration for the early future is for the 110,000-volt line from Ottawa to Chats Falls, already mentioned.

### Chats Falls Frequency-Changer Set

A brief statement of the use which has been made of the frequency-changer set at Chats Falls and of its place in the economy of the system's operation may be of interest to you. For several weeks during the summers of 1936 and 1937, as a result of low flow in the Trent river and substantial increases in the summer demand for power, it was necessary to transfer power from the Niagara system via the frequency-changer set to meet the system primary load demand. This year, although stream flow conditions have been better than average there were short periods in August and September when the frequency-changer would have been operated to guarantee a full supply of primary power had it not been for a temporary arrangement then in effect with the Gatineau Power Company whereby the Company obligingly agreed to supply, at pleasure, a limited amount of 60-cycle power to the Eastern Ontario system in place of the delivery of an equal amount of 25-cycle power to the Niagara system.

Under this temporary "at-will" arrangement with the Gatineau Power Company for what is, in effect, a transfer of power from the Niagara system to the Eastern Ontario system, it has also been possible to transfer some surplus energy to augment the limited amount of energy which is available from time to time for disposal as secondary power in the Eastern Ontario system. Before the present transfer arrangement with the Gatineau Power Company was effective the frequency-changer was

used to effect secondary as well as primary power transfer and this procedure will be resumed should the Gatineau Power Company be unable to continue the present arrangement or whenever it may otherwise be advantageous to do so.

The frequency-changer provides a substantial standby service to the Eastern Ontario system; in amount it is at present limited to a maximum of approximately 20,000 horsepower by the capacity of the step-down transformers at Trenton, but this can be more than doubled by providing adequate receiving facilities. The value of this standby service was demonstrated early in September of this year when trouble developed in the 44,000-volt connection between Kingston and Belleville and the frequency-changer was utilized to maintain full service to customers in the Central Ontario district.

The position of the Eastern Ontario system with respect to the frequency-changer is a very happy one. Its capital cost is borne by the Niagara system and the Eastern Ontario system pays only according to its needs. When it has no need of power from the frequency-changer either for actual use or for reserve, it pays nothing. When you consider that this enables the Eastern Ontario system to obtain additional supplies from the Niagara system until its load has increased sufficiently to fully load a new power development of its own and thereafter to correspondingly reduce its takings from, and payments to, the Niagara system, it will be apparent that the frequency-changer fulfils a unique and extremely valuable function.

### Wholesale Power Supply to Industrial Companies

A matter upon which questions are sometimes asked is that of the surplus or deficit shown in connection with the supply of power to private companies in the Eastern Ontario system. To understand these financial matters, you must continually bear in mind the fact that the operations of the Commission are conducted upon a policy of providing power "at cost". Even in connection with these large industrial customers of the system, the idea is not to charge "all the traffic will bear" in order to make profits for the partner municipalities. It is rather to charge for power at rates which, over a period of years, will adequately cover the costs involved, and at the same time encourage industrial activity in the district concerned; for the encouragement of industrial activity is really of much greater importance to the municipalities than profits on the power sold by the system.

### Rural Electrical Service

Before concluding I would like to refer to the splendid progress that has been made in recent years in extending electrical service to our rural citizens. Again I shall confine my figures to the seven years, 1930-1937.

From 1930 to 1937 the miles of rural primary line in the Eastern Ontario system increased nearly 2½ times, from 1,070 to 2,604 miles. The total number of consumers also increased nearly 2½ times, from 6,780 to 16,050. But whereas the hamlet consumers just about doubled,

the farm consumers nearly tripled. The capital invested increased in the seven years from 2 1-3 millions to nearly 6 millions, and the government grant-in-aid from less than 1¼ millions to almost 3 millions of dollars. The power supplied increased from 3,305 horsepower in October, 1930, to 8,173 in October, 1937. These are impressive figures, but it is interesting to note that the lines approved for construction in 1937 alone were 617 miles to serve 682 hamlet and not less than 2,163 farm customers. It is a little too soon to obtain summary figures for the past fiscal year but it appears that the progress made in 1938 will be even greater than that made in 1937.

### Conclusion

When I think of the power situation in Eastern Ontario as it was in the early days I am amazed at the transformation that has taken place. In those days the Commission was operating the Central Ontario properties as trustee for the Province of Ontario. There was much dissatisfaction. Complaints were frequent and sometimes bitter. The brunt of the attack did not fall on me for I was then acting in a purely engineering capacity, nevertheless I well recall the spirit of those early days. The municipalities of Eastern Ontario felt that they were off the beaten track; that adequate power supplies were not available for them or for industries which might otherwise be glad to locate in their precincts. The cost of power was deemed to be unduly high and as they had no share in ownership or management the municipalities lacked any real sense of partnership.

Today, Eastern Ontario has a splendid, well-engineered and highly co-ordinated power system serving an area comparable with the Niagara system. In terms of load it is second only to the Niagara system. It has facilities capable of furnishing the power requirements of any industry that may be attracted by the numerous advantages which the east affords, at rates which stand comparison with the lowest. It has a rural service that is unequalled by any private company. It is exceedingly strong financially.

Moreover you, as municipal representatives, have a sense of responsibility. A large share of the management is now yours, for nearly all the distribution systems are now owned by the municipalities. You also have a voice in the management of the common supply system, and as long as I am Chairman I will see that your voice is heard.

In a word, you are full partners in a co-operative power undertaking which is second to none on the North American Continent or, for that matter, in the world, and as such you share in Hydro's destiny. The indirect advantages which Hydro affords to industry and to your well-being as citizens is incalculable.

What a transformation to take place in so short a time! What an achievement to the credit of Sir Adam Beck and those who followed in his footsteps!

We should try to recapture the spirit of Hydro, the spirit that Sir Adam had. Some of us, including myself, have been too immersed in the engineering and economic aspects of Hydro to envisage the whole enter-

prise in its relation to Mr. Average Citizen. We have partially lost sight of what it has done for Ontario's millions. I am only now beginning to catch the real meaning of the spiritual aspect of Hydro; only now beginning to realize how essential it is and what a responsibility falls upon me and my colleagues, for it is ours to foster that spirit, and pass it on undimmed to succeeding generations.

If we here today set our hands to the task of building Hydro for the common good, with no thought of serving sectional or local interest, there is no telling what greater things we may yet accomplish. But we must have faith in each other and we must have the will to work in harmony. In the interests of this Province I pledge you the best I have and, in return, I ask you to give your best to Hydro.

George Grosz.

## George Grosz, Waterloo

On the evening of Thursday, October 20, 1938, George Grosz, manager of the Waterloo Public Utilities Commission, passed away in his 58th year. His health had been failing for the past few years and although there did not seem to be any definite cause of his condition he gradually weakened.

Mr. Grosz was born in Waterloo, Ontario. At the age of 16 he entered employment of the Waterloo Electric Power Company and taking a course in electrical engineering in the Scranton schools became electrical superintendent of the company in 1904. When the town of Waterloo bought the company power plant in 1909, and put it in charge of the Waterloo Water and Light Commission, he was retained as superintendent of the electrical department and given full supervision of re-constructing the system for use with Hydro power. Since that time he has continued to serve in that capacity becoming manager about five years ago.

In addition to his duties with the Waterloo Public Utilities Commission, Mr. Grosz was very valuable to the town in his work on various organizations. These included the Waterloo Board of Trade, the Board of Relief, the Parks Board, of which he was

chairman, the Musical Society, of which he was president, and the Waterloo Club.

Mr. Grosz is survived by his widow and one son, also his mother, one brother and one sister.

# Economic and Other Aspects of Some Utility Metering Problems

*By E. G. Ratz, Electrical Engineer, Canadian Westinghouse Company, Limited, Hamilton, Canada

*(Continued from September)*

### Making Use of Meter Overcurrent Performance

In Fig. 5 is shown the overcurrent performance of modern watthour meters demonstrating that such meters may be used to about 400 per cent. of current rating without material inaccuracy.

For a 60 ampere 3 wire service a 15 ampere meter is therefore adequate under all conditions.

For a 100 ampere 3 wire service a 25 ampere meter is adequate under all conditions and a 15 ampere meter is adequate if the load exceeds say 50 amperes or 60 amperes only for short periods.

For a 60 ampere 2 wire service a 15 ampere meter is adequate under all conditions, and unquestionably a 10 ampere meter is quite sufficient under all but very exceptional circumstances.

Making use of meter overcurrent performance as outlined has the distinct advantage that meters of lower ratings may be applied and correspondingly better registration obtained

TABLE I.

| Capacity of Service | Rating of Meter | Meter Accuracy Range Modern Meter | Obsolete Meter |
|---|---|---|---|
| * 60 amp. - 2 wire | 10 amp. | 10 to 4000 watts | 10 to 1100 watts |
| 60 amp. - 2 wire | 15 amp. | 15 to 6000 watts | 15 to 1650 watts |
| * 60 amp. - 3 wire | 10 amp. | 20 to 8000 watts | 20 to 2200 watts |
| * 60 amp. - 3 wire | 15 amp. | 30 to 12000 watts | 30 to 3300 watts |
| * 60 amp. - 3 wire | 20 amp. | | 40 to 4400 watts |
| * 60 amp. - 3 wire | 25 amp. | 50 to 20000 watts | 50 to 5500 watts |
| *100 amp. - 3 wire | 15 amp. | 30 to 12000 watts | 30 to 3300 watts |
| *100 amp. - 3 wire | 20 amp. | | 40 to 4400 watts |
| *100 amp. - 3 wire | 25 amp. | 50 to 20000 watts | 50 to 5500 watts |
| 100 amp. - 3 wire | 40 amp. | | 80 to 8800 watts |
| 100 amp. - 3 wire | 50 amp. | 100 to 40000 watts | 100 to 11000 watts |

* commonly used ratings.

at light load. In fact the light load to which a meter of a given type will be accurate is extended downward in exact proportion to the meter current rating used.

Assuming 1 per cent. as the minimum current at which a meter will register accurately or at all, then the advantage of making use of the overcurrent characteristics of meters will be clear from Table I. From the table the advantage at light load of a 15 ampere 3 wire meter will be obvious, as will also the advantage of a 10 ampere 2 wire meter over a 15 ampere 2 wire meter.

In applying modern meters the best results are obtained if the maximum loads are co-ordinated with the maximum current which the performance of the meter will permit. Failure to so co-ordinate the maximum loads with the performance not only results in loss of the overcurrent performance available in the meter, but results in a poorer light load accuracy as well.

METERS OF OBSOLETE CHARACTERISTICS

This is related largely to the heading on "Overcurrent Performance".

The question of discarding and replacing meters of obsolete performance is one that has been brought up repeatedly — but without adequate response on the part of the utility authorities.

Fig. 5 shows the performance of a modern meter compared with that of a meter having obsolete characteristics and purchased prior to say 20 or 25 years ago. While meters made more than 20 or 25 years ago were certainly excellent meters in their day, nevertheless the development of the metering art has been such that since that

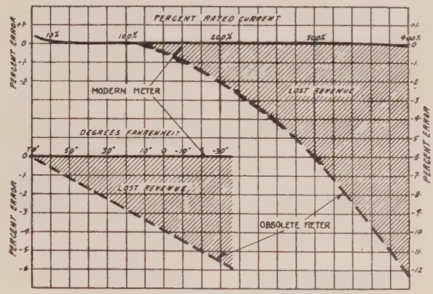



*Fig. 5—Overcurrent performance of modern watthour meters compared with one having obsolete characteristics.*

time the overcurrent and other performances have been revolutionized.

The comparison of accuracy on overcurrent speaks for itself.

The temperature characteristics of obsolete meters are also poorer than those of modern meters, a fact which is often overlooked. Very few meters are located so that the temperature in winter is as high as approximately the 70 deg. fahr. at which they were calibrated. As is well known, uncompensated watthour meters tend to run slow in proportion to a drop in temperature, as shown in Fig. 5.

Table I shows the comparative range of loads over which modern and obsolete meters have approximately equivalent accuracy. Keep in mind, of course, that even within the range shown in the table the modern meter has a better performance under such circumstances as voltage variation, temperature variations, power factor, and similar conditions.

If the resultant performance due to operation on overload, low temperature and other characteristics, should cause an obsolete type of meter to under-register by say 1.5 per cent.,

then with a $5.00 monthly account the loss due to such an obsolete form of meter would be about 90 cents per annum. In ten years this would amount to about $9.00 which would nearly pay for the entire cost of a modern meter—in say a little over two five year Government seal periods.

Another aspect of using meters with modern characteristics is that the cost of the meter itself is by no means the total cost of rendering the account to the consumer. In addition, there is the matter of testing and servicing, the Government inspection fee, the cost of the installation of the meter, the expense of reading the meter monthly or bi-monthly, the keeping and issuing of the accounts, and the expense of collections. It will be clear that the cost of the meter is only a proportion of the total expense involved in measuring the consumer's energy, and rendering and collecting his account. The billing costs in excess of meter cost are fixed, but the revenue to meet them depends directly on the meter accuracy.

Basing the depreciation of meters on a life of 20 or 25 years—which is undoubtedly as long a time as would be allowed by accounting methods—most of the meters with obsolete characteristics can now be written off entirely without loss. Certainly meters made prior to about 1906, which have still poorer characteristics, could and should be written off without any financial hardship whatsoever.

### Current Transformers

An instrument transformer multiplies the registration of the meter by its ratio, and as inaccuracies are similarly multiplied, good accuracy is of prime importance. When current transformers are used the loads are large and the amount of power involved is therefore correspondingly important.

There are probably few pieces of equipment purchased by utilities where so little attention is paid to performance, considering the effect which such performance may have on the accuracy and registration, as in the case of current transformers.

The custom seems to have been to purchase instrument transformers and particularly current transformers, for ordinary service metering, merely as a piece of equipment without any particular reference to performance. Certainly few utilities check the quality of the performance carefully and in detail when purchasing.

In the first place a polyphase installation requiring current transformers is now limited in current rating to the primary rating of the current transformer. This immediately limits the range of current over which the metering installation may be used and makes it impossible to take advantage of any overcurrent capacity characteristics of the polyphase meter. Inability to use a lower full load rating has a corresponding effect on the light load performance.

Current transformers without overload characteristics require more changes in current transformer ratings to conform with load changes, if best accuracy is to be maintained, than is the case with self-contained polyphase meters, or than is the case if current transformers are used which can be operated at currents in excess

of primary rating in the same manner as the meters may be so operated.

A current transformer having an overcurrent rating somewhat similar to that of the meter will provide a much better light load accuracy, make full use of the meter characteristics on overcurrent, and at the same time, by extending the current range of a given installation, reduce the variety of capacities which must be provided and consequently the amount of inactive equipment which may be left from different installations as they are changed from time to time.

Fig. 6 shows a comparison of the performance of maximum rated current transformers as now commonly used and a new form of current transformer having overcurrent characteristics.

The dotted lines in Fig. 6 show the performance of a good current transformer of the type heretofore available.

Note particularly that the capacity of the meter as to accuracy at light load for the dotted curves is limited to a much higher current than the 1 per cent. starting current available in self-contained meters. Also note that there is no overload capacity at all on the dotted curves. Briefly, this type of current transformer restricts the range over which the current may be measured accurately to that portion of the curve shown (in dotted), which range is from one-half to one-third of that over which the meter is useful.

The full line curve in Fig. 6 shows the performance of the newer through type current transformer illustrated in Figs. 3 and 4, which is the

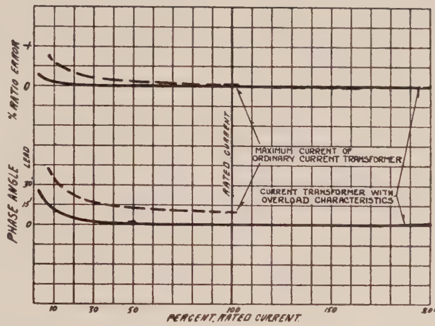



*Fig. 6—Comparison of performance of current transformers.*

same current transformer used in the metering box shown in Fig. 2.

Note the improved accuracy obtained throughout from the newer through type current transformer, particularly the extended range of accuracy on light loads, and the use made of the overcurrent performance of the meter. With this current transformer full advantage is taken of the meter performance characteristics and the current transformer places practically no limitation thereon.

The through type current transformer illustrated can be had with a ratio as low as 200/5 and operates the meter down to about 2 to 3 per cent. of rated capacity, i.e. down to about 5 amperes or less. On the other hand, this current transformer is accurate up to over 200 per cent. of rating, i.e. to over 400 amperes.

Two current transformer ratings of say 200/5 amperes and 600/5 amperes, which are interchangeable mechanically, provide an accurate range of registration from about 15 amperes to 400 amperes, and from about 30 amperes to 1200 amperes for the respective ratings. With these two ratings

a range of current from 15 amperes to over 1200 amperes is covered accurately.

### Watthour Meter Protectors

Utilities whose distribution circuits are subject to lightning disturbances should install suitable lightning arresters, particularly for the protection of self-contained polyphase meters.

Lightning disturbances may cause the meter to break down or entirely destroy it. This is sufficiently serious as far as the individual meter is concerned but it is not by any means the most serious aspect of the situation from an economic standpoint.

A lightning arrester used with a polyphase meter does more than merely save a meter from destruction or break down. Lightning disturbances are apt to burn off a voltage coil lead or otherwise put a single element of a polyphase meter out of commission. If a single element of a polyphase meter is affected the meter continues to register inaccurately on the other element only, to the detriment of the utility, and there are instances where disputes involving many thousands of dollars have arisen due to the operation of a polyphase meter for an unknown length of time with one element out of commission. Unless very conclusive evidence can be produced as to when the accuracy of the meter was affected (which is almost impossible to do when it is damaged by lightning) it is not possible for a utility to collect for power consumption more than three months prior to the time the meter was found to be inaccurate.

The practice of installing suitable lightning arresters for the protection of watthour meters is relatively inexpensive and protects not only the meter itself, but what is more important protects the revenue registered by the meter.

NOTE:—The statements and opinions in the foregoing are those of the author and are not necessarily accepted by the Hydro-Electric Power Commission of Ontario.—EDITOR.

# THE BULLETIN

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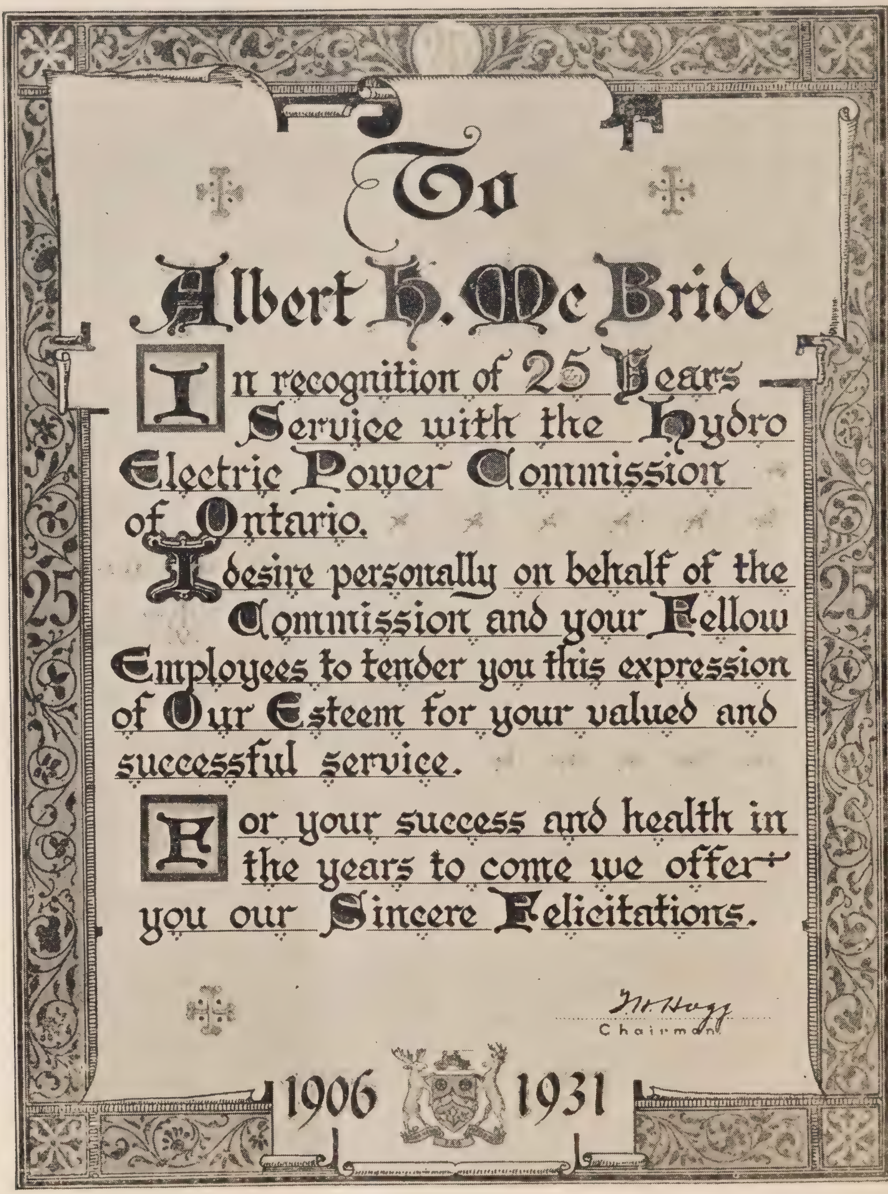
# Quarter Century Club

ON the evening of Friday, November 18th, 1938, 262 of the employees of The Hydro-Electric Power Commission of Ontario who had served for over twenty years met with the Hydro Commissioners at the King Edward Hotel, Toronto, for their third Annual Dinner and their first dinner as The Ontario Hydro Quarter Century Club. The original organization was known as The Twenty Year Club, of which all employees of the Commission who had completed twenty years of continuous service with the Commission were automatically members.

Recommendations had been made to the Commission for some tangible form of recognition for those of the staff who have had long service. During the past year the Commission authorized the granting of extended vacations to those employees with twenty-five or more years' service, and in addition, the presenting to each a gold service button and a long service certificate. In line with this the name of the Club was changed from "Twenty Year" to "Quarter Century", the membership to include those who have completed twenty years' service as of October 31st, 1938. Other employees will become members automatically on completing their twenty-five years.

The dinner, therefore, was made the occasion for presenting for the first time the long service buttons and certificates by the Commission. Owing to the absence of Dr. T. H. Hogg, Chairman, the Honourable William L. Houck, Vice-Chairman of the Commission, acted as toast-master. In a brief address he congratulated those present on their length of service, pointing out that the interest and loyalty of the staff since the beginning of Hydro had been an important factor in making the satisfactory state of the enterprise that has existed down through the years. There were also addresses by J. Albert Smith, Commissioner, and W. W. Pope, who was Secretary of the Commission from 1909 to 1936. Following the addresses, Mr. Houck, acting on behalf of Dr. Hogg, and assisted by Mr. Smith, presented the long service buttons and certificates


To
Albert H. McBride
In recognition of 25 Years Service with the Hydro Electric Power Commission of Ontario.
I desire personally on behalf of the Commission and your Fellow Employees to tender you this expression of Our Esteem for your valued and successful service.
For your success and health in the years to come we offer you our Sincere Felicitations.
T. Hogg
Chairman
25 25
1906 1931

*Long Service Certificate.*

to 109 recipients whose names are listed below.

Officers for 1939 were elected as follows:—

President - - T. C. JAMES
Vice-President - J. S. LOTIMER
Secretary - - T. MCFADYEN
Treasurer - - J. P. MORGAN

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Vol. XXV. No. 11
November, 1938



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*


*Design of gold service button, twice diameter.*

Quarter Century buttons and certificates were presented to the following, the names being listed in the order of seniority for completion of twenty-five years of service with the Commission:—

ALBERT H. MCBRIDE
EDGAR T. J. BRANDON
COLIN C. MCLENNAN
JAMES N. WILSON
FREDERICK T. STOCKING
WILLIAM L. AINLAY
CLARENCE C. BODLEY
GEORGE G. TERRY
ARTHUR E. DAVISON
ELLEN KEATING
WILLIAM W. POPE
WILLIAM G. PIERDON
STEPHEN R. A. CLEMENT
BRENDAN MULHOLLAND
JAMES S. LOTIMER
JAMES A. LAWRENCE
DONALD M. JOHNSTON
WILLIAM E. LANGTON
WILLIAM O. G. WALKER
GEORGE W. HOWSE
ALEXANDER QUIGLEY
CHARLES H. SHEPPARD
TOLVER R. POSTLE
EDMUND S. LAPPE
THOMAS D. CAMERON
ESTYN ROBERTS
WILLIAM MCKENZIE
WILLIAM G. HEWSON
GEORGE L. WATTS
FRANK TAYLOR
WALLACE W. TROTT
EMILE O. J. VLOEBERGS
ALEXANDER MCPHERSON
ROBERT W. FUNNEL
FREDERICK D. LINTON
JAMES H. ROGERS
BENJAMIN HILL
STANLEY M. RICHARDSON
CHARLES L. BELFORD
RICHARD M. A. THOMPSON
ARTHUR C. GOODWIN
GEORGE AUSTEN
COLIN S. GRASETT
BANCROFT O. SALTER
SAMUEL STAINES

Charles McEvoy
George A. Saunders
Alfred S. L. Barnes
John H. Caster
George F. Ronald
Henry C. DonCarlos
Leonard K. Elliott
Ernest Pomfret
Joseph G. Bell
Ernest A. Russell
Fritz V. Martin
Edward G. Archer
Alfred J. Moir
Clifford T. Woodley
William A. Stringham
Ethelbert E. Moore
James P. Smith
Tudor C. James
Frederick L. Gamauf
George G. Cousins
Edward R. Adderman
Jesse C. Hagerman
William H. Fawcett
Duncan McCuaig
Edward J. Taylor
George L. Rouse
Francis W. Clark
Richard T. Jeffery
Daniel A. McKenzie
Secor W. Johnston
Arthur H. Hull
Thomas H. Hogg

Harold J. Surtees
Walter H. Cookson
Arthur G. Lang
George J. Mickler
Thomas F. Elphick
Andrew C. Holcombe
Arthur B. Sawyer
Henry A. C. Renshaw
Frank E. Cooney
Robert J. Wilson
George Staines
Harold L. Bucke
Walter A. Salisbury
James A. Keogh
John J. Jeffery
Harry J. Muehleman
Melville C. Hare
Riel J. Worden
Gordon Pace
Otto Holden
James Logan
Walter L. Amos
Alexander M. MacLachlan
Walter H. Mills
Edgar N. R. Durie
George Foster
Roderick B. Young
Thomas S. McFadyen
George A. McNaught
George A. Curry
Ernest F. Steele
George A. Ironside

# The Thunder Bay System

## By Dr. Thomas H. Hogg

I FEEL that I am no stranger to this remarkable district of yours. My acquaintance with it began just a quarter of a century ago. In 1913 I placed the original survey party which collected data for a power development at Dog lake on the Kaministikwia river, and in 1917 I organized the Nipigon river survey. This work took me all over the Kaministikwia and Nipigon rivers. Later I looked after the design and construction of the Cameron Falls development. Then in 1925 the Commission undertook the Virgin Falls dam and in 1930 the Alexander development. Further extensive surveys on the Nipigon river between Pine Portage and lake Nipigon have also been made with a view to additional supplies of power for the district when needed. Pleasant recollections of many visits to Port Arthur and Fort William are associated with these activities.

The Dominion of Canada, being a small country with respect to population but one of the greatest with respect to area and wealth of natural resources, is faced with tremendous expenditures in maintaining its proper national development. It produces from its great wealth of natural resources far more than its small population can consume, and it must depend upon its exports to world markets to provide the means by which it can consistently progress. With this lakehead district playing such an important part in the operations of three of the great industries upon which Canada depends for maintaining its world position, that is the *grain trade,* the *pulp and paper industry* and *gold mining,* you the citizens of Port Arthur and Fort William, occupy an enviable position, which, however, entails great responsibilities. To discharge its responsibilities and function as it should, in order to fulfil the destinies thrust upon it by its geographical position, the Thunder Bay district must have available an *abundance of cheap power.* Through the vision of Sir Adam Beck, and the cooperation of the cities of Port Arthur and Fort William with The Hydro-Electric Power Commission, this feature has been adequately provided for.

The early history of the Thunder Bay system is intimately bound up with the history of Port Arthur. Port Arthur has ever been a public-ownership city. Port Arthur and Fort William were among the first municipalities in Canada to operate their own electric street railway, and their own telephone and water works system. With this foundation firmly established away back in the "nineties", they have never let pass an opportunity to declare themselves by popular vote for municipal ownership and to do so in unmistakable terms.

Since 1920 the power supplies of the Thunder Bay system have been dependent upon the Nipigon river. The splendid power possibilities of this

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An address given at a dinner in Port Arthur on October 20, 1938.

river, situated in the midst of a heavily wooded, almost virgin forest, so ideally furnished with natural storage and in consequence so well adapted to supply the continuous demands, hour after hour, month after month, incidental to the manufacture of wood pulp and newsprint, were almost lost to public ownership. But for the courageous and indefatigable efforts of Sir Adam Beck, this remarkable stream would not have been reserved for public development and put to its present beneficial use.

I do not propose to dwell upon those very early days, upon their trials and tribulations, or upon the high courage and tenacity which eventually triumphed in the face of many grave difficulties. Neither do I propose to reopen the contentious issues surrounding the initial development of Cameron Falls, or the outburst of scathing and bitter criticism throughout Ontario and Canada which greeted that venture and which found a gleeful response in the United States, culminating in the vicious misrepresentations of the Murray-Flood report.

The success of the Cameron Falls development has long since been conceded, much to the dismay of its many critics, and I need scarcely tell you that the swift and dramatic character of that success, which startled friend and foe alike, was entirely attributable to the truly remarkable development of these twin cities of Port Arthur and Fort William and the Thunder Bay district as a whole.

It would seem, however, that the success of your second venture at Alexander is not yet universally conceded; that there is, in fact, some difference of opinion about it. This may be attributable to lack of appreciation of the significance of the facts. Whatever the explanation, it is a regrettable misconception which might have harmful consequences and which, therefore, calls for some comment from me tonight.

As a background to a discussion of the power development at Alexander and to what I shall later have to say about other matters, I should first sketch in brief outline the remarkable load growth that has taken place in the Thunder Bay system, the need for system power reserves and the maximum safe operating capacity of the Cameron Falls plant, as a sole source of supply for the system.

### Cameron Falls Capacity

While there are six generating units in the Cameron Falls plant having an aggregate capacity of 75,000 horsepower at normal head, this capacity is not strictly dependable. It is a foregone conclusion that at intervals one unit will be out of service for maintenance work or even breakdown repairs and it is unthinkable that the basic needs of the industries of the Thunder Bay district should be seriously curtailed for weeks or months because of an eventuality that is not only foreseeable but certain to occur.

The highest figure that can be given for the dependable output of Cameron Falls allowing for reserve is the capacity of five units which at flood flow is 61,000 horsepower. Moreover, the dependable regulated flow of the river closely approximates the requirements of five units and not six. The depletion of the lake Nipigon storage

by the use made of the full capacity of six units in 1929 and 1930 lends ample confirmation to this. From the point of view of a single plant as the sole supply to the system the sixth unit is, therefore, distinctly a spare, although it has full reserve value against breakdown. In what follows, therefore, the dependable capacity of the Cameron Falls generating station will be taken as 61,000 horsepower.

### Growth in Primary Load

With this in mind, let us examine the growth of *primary* load. Commencing in 1911 with a peak of 2,000 horsepower, the load grew to 6,950 horsepower in 1920. By the fall of 1925 it reached the amazing figure of 49,600 horsepower, fully loading four of the five units then installed in the plant. Early in 1926 a sixth unit became available at Cameron Falls; and there followed a pause of two years without growth in peak demand. Then in 1928 it shot up to 67,000 horsepower, exceeding the dependable capacity of the plant by 6,000 horsepower. In 1929 and 1930 the primary peak loads were only slightly less than 78,000 horsepower, which exceeded the capacity of all six units by 2,000 horsepower; by good fortune the excess over and above the capacity of the Cameron Falls plant happened to be obtainable from the Kaministiquia Power Company.

The depression that followed is history. However, in only two years (1931 and 1932) did the primary peak load for the year drop below the dependable capacity of the Cameron Falls development. From 1933 to 1935 the primary load climbed steadily from a peak of 66,200 horsepower in 1933 to 70,500 horsepower in 1935, rising sharply in 1936 to 83,400 horsepower, and in 1937 to 88,500 horsepower. In September it was only a little less than 96,000 horsepower—which means that it has exceeded the dependable capacity of Cameron Falls by almost 35,000 horsepower.

These figures are for primary load only, and are exclusive of secondary power sold for the generation of steam to which I shall refer again later. The total load, including secondary power for steam, from 1933 onward has approximated and even taxed the full combined capacity of both the Cameron Falls and Alexander developments.

Moreover, these figures for loads actually carried give no indication whatever of additional load which from time to time, looking forward, appeared almost certain to materialize. In this connection it must be remembered that projects to provide capacity for anticipated future power needs must be undertaken in advance of the materialization of those needs. A policy so cautious as to tolerate an accumulation of unsatisfied demands prior to undertaking new developments is unthinkable. In the case of a plant like that at Alexander, a *minimum* interval of from eighteen to twenty months between authorization and readiness to carry load must be allowed.

Returning now to 1926, it will be remembered that, with the steady growth in municipal load and the tremendous expansion in the pulp and paper industry, the load had already reached the capacity of four units at Cameron Falls and had been increas-

ing at a phenomenal rate. During that year (1926) additional contracts were executed between the Provincial Government and the various pulp and paper companies operating in the Thunder Bay district, awarding extra timber limits and calling for a definite production output by each company. There was every indication that additional power development was necessary and as about two years would be required to construct the Alexander plant this work was authorized and begun in June, 1926.

In 1927 the pulp and paper industry experienced a temporary setback as a result of which the Commission suspended work on the Alexander development. However, in the face of the very marked resumption of activity and increase in load which occurred in 1928, when the load itself actually reached a point in excess of the dependable capacity of the Cameron Falls plant, the Commission naturally decided to complete the Alexander development.

The details of the work program are, of course, unimportant for our present purpose nor will it be profitable to trace in detail the effect of the depression upon industry. It is, however, worth noting that the load of the Thunder Bay system is of a highly industrial character, dominated by three activities: pulp and paper, grain transportation, and mining. In fact it is more industrialized than the load of any other system of the Commission. It is also significant that the pulp and paper industry is peculiarly sensitive to any depression or recession in business activity. This fact coupled with the reduction in the activity of the grain trade over a period of years gave a setback to the primary power demand on the Thunder Bay system from which it did not completely emerge until 1936 and 1937.

### SECONDARY POWER

It must not be supposed that the added power resources furnished by the Alexander development have been allowed to remain idle. All things considered, they have been used with telling effect; chiefly by taking advantage of "process" steam requirements for the manufacture of wood-pulp and paper. Arrangements were made with a number of companies which enabled them to obtain their process steam from electric steam generators at a comparatively low energy rate. Both the Thunder Bay system and the companies benefited by this transaction; the system put to beneficial use power resources which otherwise would have wasted and the companies effected material operating economies at a time when, owing to the state of the newsprint market, any saving in cost was helpful. Furthermore, Canada benefited by the substitution of an expenditure for electrical energy produced in Canada, for an expenditure for fuel from a foreign country.

As I have already inferred, it is sound engineering and economic practice for power systems to carry a reserve over and above primary power requirements and it is equally sound to utilize such reserves and dispose of them for any secondary purpose which will yield revenue and thereby reduce the cost of carrying the reserves. The amount of reserve which it is advantageous to carry in this way depends upon a number of factors including

the secondary revenue which can be derived from its sale. I do not suggest that the power reserves on the Thunder Bay system have been in proportion to the system's requirements, but I do point out to you that on this system you have had an extraordinarily large amount of industrial equipment standing idle and, in consequence, you have been constantly confronted with the possibility of a rapid resumption in activity which would increase the demand for power at an extraordinarily high rate which, in turn, justified the carrying of a larger reserve than under more normal conditions would be the case. As your load grew, it was a simple matter to curtail the sale of secondary power and utilize corresponding resources for the production of primary power.

### FUTURE POWER SUPPLIES

What, you may ask, of additional power supplies for the future. This matter has already received attention. Physical surveys have been made and they have been supplemented by economic studies to determine just what form the next development should take.

The dependable capacity of your present system, after making allowance for needed reserves, is little more than 100,000 horsepower. The primary load in September of this year reached 95,824 horsepower, the highest primary load ever recorded. The increase was due to the extra demands of the grain trade. It may be desirable to commence another project comparatively soon, so that within two or three years, depending upon expected load growth, it will be available for use.

I would remind you that the interests of the Thunder Bay system are too large to be satisfied by small palliative measures. That issue was decided to your advantage in 1917 when the Cameron Falls development was undertaken; it was clear when Alexander was developed and it is equally clear now. Port Arthur and Fort William must go forward, their citizens would not be content to accept a static situation. Is there anyone here who does not agree that as we face the future we will with one accord say: "Adequate advance provision must be made for the bona fide growth requirements of the Thunder Bay system"? Is it not also clear that this is precisely the situation with which the Commission was faced in 1925 when the load reached the dependable installed capacity of Cameron Falls and the Alexander project was authorized? And does it not give emphasis to the fact that the Commission's action in going ahead with the Alexander development must be viewed in the light of the facts available at *that* time, *not* in the light of those available now?*

When we determine whether we are

*A clear understanding of the relationship that the dependable capacity of the Cameron Falls generating station bears to the actual primary peak loads that have been carried by the Thunder Bay system, may be obtained by turning to the peak load diagrams on pages 54 and 55 of the Commission's Annual Report for 1937. If a line be drawn across both of the diagrams at the height of the dependable capacity of the Cameron Falls generating station, which as noted above is 61,000 horsepower, the amount by which the system monthly peaks exceeded, or fell below, the capacity may be seen at a glance. The diagram on page 54 which shows the total load—which up until 1931 was all primary—may be used up to that year, and the diagram on page 55—on which both the primary and secondary loads are given—may be used for the years 1932 to 1937. It will at once be obvious that in each year from 1928 to 1937 inclusive the primary peak load of the Thunder Bay system exceeded the capacity of the Cameron Falls generating station, excepting only the two depression years of 1931 and 1932.

going to risk a shortage of power in the Thunder Bay system or proceed with additional power developments we will not be blessed with hindsight, but at the proper time, this Commission is prepared to sit down with you, display the facts and before commitments are made get your views on this important question.

Having reviewed the growth in load and the power supplies of the Thunder Bay system and considered the place of the Alexander development in its relationship to these historical facts, I wish to discuss with you a few matters which are at present of particular interest in connection with the Thunder Bay system. First let us consider the mines and mining loads.

### Mines and Mining Loads

Some little time ago I obtained from a friend a summarized statement of the disbursements of a large mining company which operates in the Thunder Bay district. I had always felt that the indirect benefits of the mining industry in Ontario were enormous, but I was nevertheless deeply impressed by the magnitude of the moneys spent and the significance of those expenditures, especially to Port Arthur and Fort William which are directly connected by telephone with the mines in order to facilitate the placing of orders.

Reference has been made to the unusual susceptiblity of the pulp and paper industry, and perhaps also of the grain trade, to periods of industrial depression. Fortunately the gold mines have not been so affected. On the contrary, they have shown remarkable stability and have been a pillar of strength in the industrial life of the Thunder Bay district and indeed of Ontario as a whole. This being the case, how fortunate it is that you had an ample supply of power for the mines and that their development in the Thunder Bay district has at no time been retarded by lack of power resources. How fortunate too that the mines were located and developed at a time when they have been of material direct assistance in carrying a portion of the system generating capacity in excess of primary requirements for other purposes.

When I think about the advantages which accrue to Port Arthur and Fort William as a consequence of their close geographic and economic connection with this splendid mining field, it is not surprising to me that you attach great importance to the mines and attribute at least a portion of your recent remarkable achievements to indirect benefits from the mines.

In 1922, in an illustrated booklet published by the Commission relating to the Thunder Bay system and the Nipigon river developments, it was stated:

> "With such great mineral resources as have just been referred to and which are as yet practically untouched, there can be little doubt that the Thunder Bay district has a great future before it in the reclamation of its minerals and their adaptation to industrial uses".

Although made in the year 1922, it was not until more than a decade later that fulfilment of this forecast came about. There are now eleven mining properties served by the Commission,

nine of which are producing mines and two are developing. The aggregate load in August, 1938, was 9,683 horsepower. The maximum load of any one mine was less than 2,000 horsepower, and the minimum demand about 200 horsepower.

### Rates for Mines

Recently a problem of determining what constitutes appropriate and reasonable rates for mines has been calling more and more insistently for attention; while I am not in a position to-night to say a great deal about this, you may be interested in my tentative views. There is an obvious element of risk about the life of mines, which I think demands that the rates for power sold to mines should be such as not only to cover the costs including proportionate share of standard reserves, but also should insure the retirement of any special investment in a period well within the life of the particular mine concerned. For the present, the Commission has standardized on ten years as a reasonable time in which to write off such capital, and it is significant that, on this basis, no profits have been made prior to the present year. However, as the mining load grows there will inevitably develop a certain diversity between the loads, and not only will the loss of the load of one mine be less serious, but other mines will no doubt be seeking to obtain supplies of power, for which in many cases the Commission will be able to utilize, at least in part, transmission and generating facilities already provided. When, therefore, a stage is reached at which *on the average* the fulfilment of these conditions is well assured and when in addition there is a margin of profit to spare, then I feel that the question of reducing the rates to mines by an amount which will terminate such profit should receive consideration.

It is well to bear in mind that municipal interests are recognized as paramount but that municipal interests cannot be divorced from the interests of the mines which are now playing such an important part in the economy and development of the Thunder Bay district and indeed of Ontario. There should be no thought of making an exorbitant profit on the sale of power to mines for the benefit of the municipalities or of the Province. The interests of the municipalities and the Province will be better served by charging the mines a price for power which encourages their development and which, in consequence, affords a rich return in indirect benefits.

### The Cameron Falls Housing Project

I would like here to offer a word of comment and explanation relating to the much publicized housing project now nearing completion at Cameron Falls.

For many years the greater portion of the Commission's operating staff at Cameron Falls has been living in very unsuitable buildings erected in 1923 to house the construction staff. As these buildings were cheaply constructed for temporary use only, it is not surprising, after fifteen years, that it became impracticable and uneconomical to maintain them, and that they were utterly inadequate as dwellings.

Over a year ago the former Commission decided, and so far as I know

the wisdom of that decision has never been questioned by anyone, that these buildings should be replaced, and authorized the necessary expenditure. The wheels were set in motion and in due course tenders were called for and the job was let to the lowest bidder.

Later it became apparent that some of you looked upon this procedure as highly arbitrary and altogether unjustifiable on the ground that the municipalities of Port Arthur and Fort William had not been consulted. Before I could orient myself to this viewpoint, not unnatural as I now see it but none the less distinctly surprising and novel to me, a controversial issue of seeming importance had grown out of whole cloth.

I have since explained my position by letter to the Public Utilities Commission of Port Arthur, this city being the storm centre, and I now desire to make it clear to you even though some repetition is unavoidable.

The Hydro-Electric Power Commission of Ontario has no desire to be arbitrary or dictatorial. It is not only willing to work in a spirit of friendly co-operation with the public utility commissions of the partner municipalities, it is most anxious to do so. I refer to the utility commissions because they are the duly constituted representatives of the users of electricity, and it is to the users of electricity that the Ontario Commission owes its duty.

It is our desire that there should be the freest consultation to establish facts and ascertain local wishes and local colour and I would have gladly consulted about this housing project had I realized that you would have wished it. It may not have occurred to you that although individual consultation is feasible here, where two large municipalities have such a preponderating interest in one system, it would be quite impracticable in the case of the Niagara or the Eastern Ontario or the Georgian Bay systems, owing to the large number of municipalities, nor would the utility commissions have expected it; thus there was absolutely no precedent for consultation as to the advisability of making an expenditure of this sort, which, after all, is less momentous than others that are made from time to time, but which are so technical that consultation would scarcely be expected.

In short, although I was not on the Commission when this work was authorized, and although I would have been glad to consult you, I certainly would have overlooked doing so.

There is another angle to this matter which I will not reopen to-night because I know that it has been dealt with to the satisfaction of the Public Utilities Commission of Port Arthur. I refer to the employment of local labour on the Cameron Falls housing project, and the established fact that although some half-dozen non bona fide local residents were inadvertently employed by the contractor, both this Commission and the contractor acted in good faith.

I have said that the Commission is anxious to co-operate and consult with you and I have no reservations in mind on that score. Of this you will be able to judge for yourselves as time goes on. In my view any

earlier mistakes or causes for irritation on either side no longer matter. The slate should be wiped clean and a fresh start made. But I must remind you that willingness to co-operate and consult does not imply readiness to transfer to you a function which is ours. Responsibility for matters of management which by statute have been entrusted to The Hydro-Electric Power Commission of Ontario cannot be shifted to any municipality or group of municipalities. That responsibility rests upon this Commission and this Commission must and will exercise its best judgment and make decisions and take action accordingly. I am sure that you would not have it otherwise.

While I am on this subject I want to urge upon you the desirability of exchanging personal visits as much as possible. Friendly personal contacts go far to eliminate misunderstandings and cement cordial relations. My colleagues and I shall be glad to have you visit us at any time, and we hope you will come often.

FORT WILLIAM'S SPECIAL PROBLEM

I would like to make acknowledgment of my appreciation of certain special difficulties which confront the Hydro-Electric Commission of Fort William. The fact that the Kaministiquia Power Company supplies the greater portion of the industrial load of Fort William prevents the municipal Hydro Commission from getting the benefit of diversity between the industrial load and the lighting and commercial load, and this involves a severe monetary loss. Efforts heretofore made to find a solution to this problem have not been successful. Nevertheless, a basis which promises successful settlement has been visualized and has been under negotiation. While the moment for consummation has not yet arrived, the Commission will endeavour to bring the matter to a successful conclusion as soon as the time is ripe.

In the meantime it must be remembered that the Fort William Hydro-Electric Commission operates under a handicap and while it has established a splendid record, it will undoubtedly forge ahead more rapidly when this handicap is removed.

FINANCIAL STATUS AND GROWTH

In my talk this evening I have confined attention chiefly to the period since Fort William became an active partner in the Thunder Bay system. Now I know how difficult it is to retain in mind a number of figures quoted in an address, but I do wish to refer to just a few, and for convenience I shall contrast the situation in 1927 as compared to 1937, in order to give you an idea of the sound economic growth that has taken place in your system during the past decade. Let us first contrast the capital investment and the reserves. From 1927 to 1937 the capital investment in the co-operative system increased from a little more than 14 millions to about 19 1/2 million dollars, an increase of about 37 per cent. But during the same period the Commission's reserves in the Thunder Bay system became eight times as great increasing from a little more than $600,000 to 5 1/3 million dollars.

I have already referred to the growth in load. During the decade the primary load more than doubled,

and the total load which includes secondary power just about tripled.

As you know, there is included in the "cost of power" to the municipalities payments on account of sinking fund. By these payments the partnership municipalities acquire year by year a larger equity in the co-operative plant. During the ten-year period the equity thus acquired by the municipal partners of the Thunder Bay system was multiplied by more than fifteen times, increasing from $130,000 to $1,970,000. The foregoing figures relate, of course, to the wholesale or co-operative undertaking administered by the Commission for the Thunder Bay municipalities.

Turning now to the local municipal utilities, we find an equally satisfactory record. In 1927 the percentage of net debt to total assets was 30.7. In 1937 it had been reduced to 9.4 per cent. The local assets of Fort William aggregated, in 1937, $1,076,000, and the debenture balance was only $300,000. The local assets of Port Arthur aggregated, in 1937, $2,825,000, and the debenture balance was less than $125,000. During the period the local reserves and surplus of the municipalities increased by more than 100 per cent, from $1,660,000 to $3,360,000.

The foregoing figures are important because they show that during a period that includes an economic depression of the most severe character, our municipally-owned Hydro undertaking has been able to set aside its customary reserves, adequate not only for the maintenance and renewal of the physical assets, but for the retirement of its capital investment within the stipulated period. They show too that the municipal utilities are in an exceptionally strong financial position and, while maintaining rates for all classes of service which are among the lowest on the continent, have accumulated very substantial surpluses.

Let me pause here for a brief comment upon this question of public utility commission reserves and surpluses, with special reference to the accumulation by Port Arthur of a large surplus in the form of liquid assets amounting to some $800,000.

A surplus of such magnitude, over and above all reserves required under the Act, may, at first thought, seem undesirable. That it is very tempting is attested by a recent resolution of the Mayors' Association calling for municipal confiscation of the surpluses of local commissions. True the municipalities have no powers under which they could confiscate. True also the surplus is the rightful property of the users of electricity and not of the taxpayers.

This surplus, of course, has been set aside as a rate stabilization reserve to enable Port Arthur to meet transitory difficulties. Variations in the wholesale unit cost of power are unavoidable. Those which are of a transitory nature are usually caused by one of two influences or by a combination of both of them. An increase in the *wholesale cost per horsepower utilized* may be caused by:

1st. An increase in system operating costs due to the development or purchase of additional power which for a time is only partially utilized, or

2nd. An actual decrease in the amount of power utilized.

You have long been aware of the somewhat special industrial conditions which prevail in the Thunder Bay district, of the marked effect which comparatively small changes in the industrial tempo exercise upon the primary load and revenue, and of the fact that almost the entire burden of any difficulties that may arise must be shouldered by only two municipalities. With a system so sensitive to the industrial barometer, it is only natural that you should have a keen appreciation of the importance of accumulating funds during favourable periods to help carry through intervals of strain.

Two other factors have a bearing on the advisability of continuing this course, at least for a time.

1st. The Commission's reserve for the stabilization of wholesale costs may not, as yet, have been built up to a point at which it alone is sufficient to afford you the full protection which it would be advisable for you to have. In case other industrial disturbances should come, the Commission might again be forced to call upon you for rather substantial thirteenth payments just at a time when it would be most difficult to obtain additional income through an increase in rates to your consumers.

2nd. You have been able to set aside surpluses even at your present rates which are already so low that further general reductions hardly seem to be appropriate.

Under the Power Commission Act The Hydro-Electric Power Commission of Ontario must see to it that electric service is provided at cost. But in interpreting the meaning of "service at cost", the Commission is justified in taking into account the need for the accumulation of appropriate reserves such as reserves for the stabilization of wholesale and retail costs.

### Conclusion

Only recently when thinking over what I should say at a meeting of the Eastern Ontario Municipal Electric Association, I was struck by a tendency toward narrowness of viewpoints. In my own case my recent change of duties has forcibly demonstrated this. For a quarter of a century my life and interests have been inextricably interwoven with the affairs of the Commission. I have laboured on technical problems and watched and helped to supervise the development, step by step, of a gigantic, co-operative power producing and distributing enterprise. As a result of this enforced concentration upon engineering and economic features, contemplation of the human aspect of this co-operative public undertaking did not have unrestricted scope, certainly it was no part of my official duty to give public expression to it. I do not wish to imply that Hydro in its relationship to the well-being of Ontario citizens did not greatly interest me, but rather that it had not become a dominant consideration. Since becoming Chairman the transition from the one viewpoint to the other has been highly illuminating.

Viewpoints tend to be greatly influenced or coloured by specific condi-

tions of environment. The more intensely we live and concentrate on any life objective the more do our viewpoints relate themselves to our own affairs. For the moment I would like to focus your attention on an aspect of Hydro which may or may not be the one which is most familiar to you: what has Hydro done for Fort William, Port Arthur and the Thunder Bay district in general, or, if you prefer to invert the question, what have you accomplished with Hydro? There can be no question as to the answer. The facts speak for themselves. You have done wonders. Your progress has been sensational. You have done so remarkably well I am amazed that there can be any among you who dwell upon the negative rather than the positive, who in fact think in terms of the extent by which you have fallen short of absolute perfection rather than in terms of your magnificent achievements.

When you have a splendid and reliable power supply available at rates which cannot be bettered anywhere in the world, if indeed they can be equalled, what does it matter if the Alexander plant has not always been fully loaded or if there have been intervals when it was not absolutely needed as a source of primary supply. The important fact is that you have needed the Alexander plant and when you needed it you had it. Moreover, you have in this district industries which only an ample power supply makes possible, and you derive great direct and indirect benefit from them, and so does Ontario at large. You will soon need more power, and there again you have it near at hand in ample quantities. Your fight for it is won; it is yours and not someone else's, and the way for its development is already cleared. Bearing in mind that it is possible to be too close to the trees to see the woods, I cannot escape wondering whether some of you may be too close to your own great advantages and accomplishments to see them in proper perspective. It is always healthy to strive ever for better things but in a co-operative public undertaking which is so vulnerable to criticism, it is important to maintain a high morale by appreciating and not deprecating and belittling the real worth of what has been done.

I said in Belleville that we must recover the spiritual force of Hydro if our movement is to maintain its virility. We must labour for a cause rather than for ourselves, or for sectional interests. In proportion as we do so our cause will flourish and carry us along with it.

I want you all to know that I shall do my best to see that the Commission measures up to its high traditions of public service. It is for the Commission to give a lead and to show that we have the desire and the will to work in harmony with our partner municipalities, in other words, to serve you. But do not forget that we are human. We will stumble and we will err. We will need your help and I believe that when we do we will get it.

# The Water Supply Problem

## How Hydro Helps in Solving It—Shallow Well and Deep Well Systems—Cost of Installation

By L. G. Heimpel, Professor of Agricultural Engineering, Macdonald College, St. Anne de Bellevue, Que.

WHILE depressions can, and do, cause difficulties and even hardships for the farmer, there are some forms of progress in farming and farm life that even depressions cannot stop. One such thing is steadily increasing spread of the use of electric power on Ontario farms. Where, not many years ago, it was the exception to find a farm with electric lights, we now are informed that, by the end of this year, there will be about 60,000 farms in Ontario equipped with Hydro power.

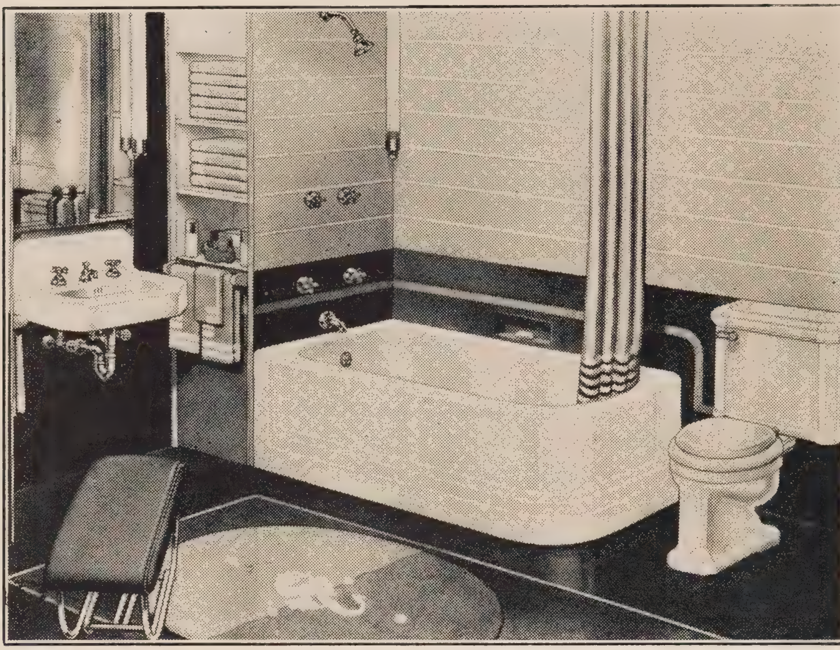
What the availability of electric power means to a farmer is usually not realized by him until he has had some experience, not only with its use, but with the cost of the service. While the first installation very often consists only of lighting service, the user soon gains confidence in his ability to pay for other conveniences. Soon the flat iron is replaced by the electric iron and this is followed by the toaster, vacuum cleaner, radio, electric washer and perhaps small motors for such work as driving an emery wheel and similar work. The conveniences of this list of devices are numerous, no doubt, but unless a farm is already equipped with a convenient supply of running water on tap, there is no convenience next to lighting which electric power can supply which is more productive of satisfaction and profit to the farmer than is the automatic, electric water system. The term "automatic" means that it looks after itself, and in an electric water system this means the following:

1. It will start and stop itself automatically so as to maintain water under pressure at the faucets at all times.

2. It will lubricate itself automatically.

3. Safety from excessive pressure will be provided through a relief valve should any of the automatic controls fail to act.

It will be apparent that an arrangement which will do all these things will be a great relief to busy farm operators to whom even the best of engine or windmill operated water systems meant something to be kept in mind and started and stopped, daily, from one year's end to the other. To have an automatic water system means that the owner has a system which is the equivalent, on his farm, of the city water system which is provided for the city dweller only by the expenditure of hundreds of thousands of dollars. Yet, the automatic water system on the farm need not cost more than a few hundred dollars, this cost including all the piping as well as the motor, pump, tank and the necessary pressure switches and valves.



*With Hydro and other conveniences there is no reason why homes in the country should not have as satisfactory a water system as is enjoyed in the most modern and up-to-date city home.*

Occasionally one comes across farms on which good springs are located, though very often at considerable distances from the buildings. Frequently such springs have been put to use by the installation of hundreds—sometimes thousands—of feet of piping to carry the water to the buildings. Where there is a good supply of water of good quality and where the head or fall is sufficient to cause the water to flow freely at the buildings such systems are very satisfactory. Often, however, the cost of the pipe line is so great that piping of too small a diameter is put in and the system is only a mediocre success. Where electric power is available the cost of a drilled well and the complete pumping outfit is likely to be less than that of the pipe line from a distant spring.

It must also be remembered that the new electric water systems revolutionize the storage of water. The gravity tank in the attic, with another larger tank in an elevated position in the stable or in the loft of the barn all have disappeared. Such tanks are often serious problems in the old-time water systems, first, to keep them from freezing in winter, and, secondly, to prevent damage due to their overflowing or springing leaks. Also, due to their location in the warmest parts of the house or barn, the water in these tanks was anything but cold, so that its use for drinking purposes is soon despaired of.

It is true, of course, that where a gravity system has been installed and

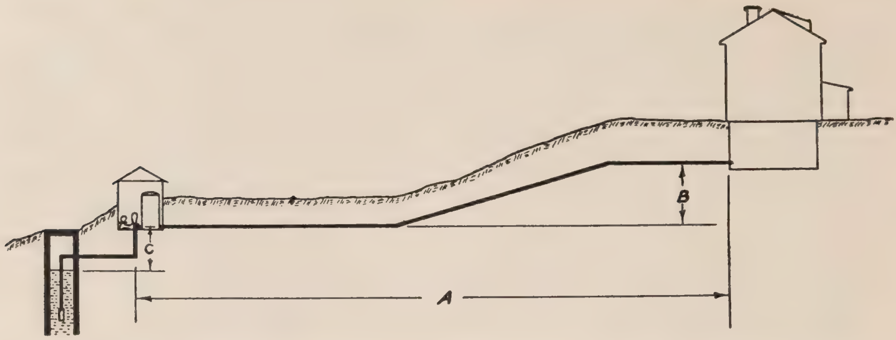
is giving acceptable service it is possible to use an electric motor to drive the pump which is always an improvement on the gas engine or the windmill, but to any farmers contemplating the installation of this type of water system we should say, by all means first investigate the self-contained, automatic pressure system. Even though a float arrangement in a gravity tank can be made to start and stop the motor in a gravity water system as the tank becomes empty or full, this kind of arrangement is comparatively costly and difficult to arrange. In many cases where a gravity system is already installed, therefore, it is best practice to discontinue the use of the gravity tank, and instead of it, to connect an automatic pressure system into the existing distribution system of piping.

In the pressure water system the storage tank is a strong air-tight tank of galvanized steel, the capacity of which, for most farms, should range between 40 and 100 gallons. In this tank the upper third is always filled with air just after a period of pumping, and when about a third of the tank's contents has been drawn the pump will again start. It will be seen, therefore, that the larger the tank the longer the time between pumping periods. However, a 40-gallon tank is sufficiently large for the farm home and the stock usually kept on a farm of a hundred acres. The capacity of the pump and motor will need to be larger in some cases than in others, depending on the number of stock to be watered, the depth of the well from which the water has to be drawn and the distance through which water has to be lifted after leaving the tank or the friction in the distribution system.

It is well to take note of the difference of pressure between that of an electric system and the old gravity tank systems. The electric systems of the lower pressure range will start the pump when the pressure drops to about 20 or 25 pounds and will keep on pumping until the air in the tank has again been compressed to 40 or 45 pounds per square inch when the pump is stopped. In this connection it is interesting to note that, in a gravity system, each foot of elevation of the tank over the point of delivery will give a gauge pressure of 0.434 lb., or a tank raised 10 feet above the level of the faucet will deliver water at a pressure of less than 5 lb., while a tank elevated 20 feet will give a pressure of 8.68 lb. When this is compared with the delivery range of a pressure water system set at from 20 to 40 lb. the advantages of the latter will be very evident.

Electric water systems, so far as farm requirements are concerned, are divided into two classes, the distinction being due to the depth of the well, or rather the vertical distance between the level of the pump cylinder and the lowest level to which the water sinks in the well. These two classes of systems or pumping outfits are called "shadow well" systems and "deep well" systems.

In all cases where the water is always available at a depth of not much over 22 feet below the level of the pump the shallow well system can be used. The shallow well pump is one in which the working parts of the pump, the cylinder, plunger and




*One way of installing a shallow well system where the combined suction lift of B and C, together with the friction loss incurred in the long horizontal suction line A, would make successful use of this system impossible. Placing the pump and tank in a pit reduces suction lift and protects the pump from frost.*

valves, can be built into the pump jack or driving mechanism. For this reason this is usually much the less expensive of the two classes of systems. In the deep well pump the driving mechanism and the pumping mechanism must be separated, the driving end being located above ground while the cylinder must be lowered to within suction reach of the water, or, better still, lowered completely under the water level in the well.

Since the shallow well system costs so much less than the deep well installation it is wise to use this type wherever possible. Therefore, in cases where water in the well does not sink lower than from 28 to 30 feet below ground surface it pays to dig a pit lined with concrete and to install the pump and supply tank in it so that the pump may be lowered to within suction reach of the water. (See accompanying sketch.) Sometimes lessening the vertical lift by locating the pumping outfit in the cellar of the house, or even in a pit dug several feet lower than the cellar floor, is the solution of this problem. However, it should be remembered that, unless the pit is made water-tight, it should be equipped with a reliable drain to prevent ground water from rising in the pit and submerging the pump.

Once the class of system has been settled, the next thing is the capacity of the outfit. The ranges of sizes which cover most farm requirements are the following:

200 to 225 gal. per hour, equipped with 1/6 h.p. motor.

300 gal. per hour, equipped with ¼ h.p. motor.

400 gal. per hour, equipped with 1/3 h.p. motor.

500 to 600 gal. per hour, equipped with ½ h.p. motor.

Of these, the smallest size unit is recommended for installations supplying a dwelling house only, while the 400-gallon an hour size is recommended for most installations having a requirement of from 500 to 700 gallons of water per day which covers

most farms with about 6 persons in the family and from 25 to 35 head of live stock, not including the pigs and chickens. The larger farms of the province should use nothing less than the half-horsepower outfits, and where especially high pressures are likely to be called for a three-quarter-horsepower motor should be used on this capacity of outfit.

A description of the shallow well type of automatic water system would not be complete without some reference to its probable cost. For the range of sizes given above the cost of the complete outfit will range from about $70.00 for the smallest size pump with a very small tank, to $175.00 to $200.00 for the largest size mentioned, the price varying somewhat with the design of the equipment and the size of the storage tank. When it is recalled that these systems include everything necessary to draw water from the source and to keep a supply continually available in the distribution system, their inherent economy will be realized. In windmill or gas engine driven systems the power plant often costs as much as does the complete electric system of the present, then one must not forget that, in the modern system, the feature of automatic service is thrown in.

While deep well systems are of necessity more elaborate and more expensive than the more compact, shallow well system, it is still possible also to embody in these the automatic feature of the shallow well system. Of course, the commercial deep-well, electric pump is a much superior product to the old type windmill pump in common use in many sections of Ontario. One of the faults on these old pumps is the fact that, in them, it was common practice to use a cylinder about twice the diameter of the piping with which it was connected to the pump head, the plunger being operated by a long plunger rod of steel operating inside the delivery pipe. In wells of medium depth, where the water level is not more than from 40 to 50 feet below ground surface, this type of pump gives fairly reliable service, but where the water lies at greater depths they are often far from satisfactory. The troubles resulting from such installations are usually the following:

1. Uneven, jerky action of the pump due to the excessive weight of the long, steel plunger rod which causes a heavy down-pull on the pumping mechanism on the down-stroke and adds to the weight of the water on the up-stroke.

2. Repairs to the plunger or "sucker" necessitate removal of the whole of the piping and plunger rods, usually a major operation and one which not infrequently results in lost piping, or perhaps that of the whole pump, where installation is made in a drilled well.

3. Accidental uncoupling of the plunger rods is a frequent occurrence in pumps with excessively long rods.

The fact that, in all pumps, the cylinder must be located within "suction reach" of the water at all times is, of course, responsible for all of the above troubles as well as for the fact that deep well pumps are considerably more expensive than the shallow well type. The force that drives the water up into the suction pipe of a pump is

not suction, however, but just the pressure of the atmosphere. This is about 14¾ lb. per square inch at sea level. The plunger of a pump simply makes a vacuum of the cylinder, air pressure on the surface of the water in the well immediately drives the water into the pipe to fill the vacuum. A column of water one inch in cross section area and a foot high weighs 0.434 lb., therefore the weight of the atmosphere can counterbalance a column of water about 33 feet in height. However, pump cylinders are not 100 per cent. efficient, therefore the "suction lift" of a pump is not over 25 feet and usually not much over 22 feet can be considered as safe distance between the level of the cylinder and the lowest level to which the water drops in the well. In drilled wells the water often drops considerably during periods of pumping. Tests should always be made to ascertain the safe rate of pumping the well will stand without lowering the water beyond the reach of the cylinder. In fact, the type of pump needed, whether of the shallow or deep-well type, depends entirely on this.

Practically all of the deep-well pump troubles mentioned above are overcome by the use of the "working barrel" type of pump. This pump uses a cylinder the inside diameter of which is slightly smaller than the piping connecting the cylinder with the pump head. For this reason it is possible to withdraw the plunger rod and plunger without taking all the piping from the well. Also, since the large pipe leaves plenty of space for the delivery of the water pumped it is possible to use wooden plunger rods which, while they are considerably thicker than the steel rods, are much lighter than the latter, thus making for much smoother pump operation. Also, these rods are not connected by threaded couplings, therefore are not nearly so likely to become disconnected as are the steel rods.

Of course, the working barrel type of pump can be used in the built-up pumping installation operated by windmill, gas engine or by electric motor. And, in cases where it is desired to change from one of the two former methods to electric drive, it is possible to use the windmill pump head and all its connections to the piping of the distribution system, by installing a good type of pump jack driven by an electric motor. The system can again be made automatic by the use of an air pressure or "hydro-pneumatic" storage tank to which is connected a pressure operated switch to start and stop the motor.

The development in pumping equipment for farm use has been large and varied during the last ten or fifteen years; it is therefore obvious that even tradesmen selling pumps find it difficult to keep well informed on this subject. Nor has the busy farm operator an opportunity to make the necessary study of the variety of topics relating to this equipment. However, the agricultural engineering departments of our agricultural colleges and schools, as well as the agricultural representative service and the Hydro experts, should be capable of advising the farm user of electric power as to most economical and efficient changes any water system would require.—*The Canadian Countryman.*

# The Research Committee

of

# The Hydro-Electric Power Commission of Ontario

THE Laboratories of The Hydro-Electric Power Commission, from the time they were first organized, have been engaged in research work in connection with the problems and prospective projects of the Commission. The investigations made have provided the solutions of many of these problems and have aided and guided the Commission in the purchase of materials and in the designs of stations, power lines and other equipment, resulting in a very high standard of quality in all component parts of the several power systems.

The Research Committee was organized early in 1933 to take further advantage of the Laboratories' facilities in both staff and equipment by providing through subcommittees closer contact with the problems of other departments by better opportunity for the interchange of ideas and suggestions with those most familiar with these problems. Another important function of this Committee is the developing of worthy ideas brought forth by individual members of the staff, and very valuable results have been obtained through assistance given in this way. Also, the Committee has been co-operating with the research staffs of colleges, manufacturers and other organizations in certain studies and investigations to the mutual benefit of all involved.

Five Department Heads form the Research Committee which is concerned with general matters only. Investigations to be undertaken are delegated to subcommittees, each covering a particular field, while for the most part, the actual experimental work is carried on by the Laboratories. At present fourteen subcommittees are active: two subcommittees, organized early in the history of the work, have completed their studies and have been disbanded.

The problems and investigations undertaken by the different subcommittees are quite varied in nature being mechanical, electrical and chemical, as well as studies of physical characteristics of certain building materials. Some idea of the scope of the work can be gained from the following:

A subcommittee has been studying the vibration of transmission line conductors on long spans, reproducing the conditions on special test equipment at the Laboratories, and endeavouring to find the most satisfactory means of suppressing these vibrations and thus preventing frequent breakages of conductors in service. Very valuable information already has been obtained in these investigations.

Another subcommittee has attacked the problem of reduction of ground line deterioration of wooden poles and has developed a special sand creosote collar as a means of impregnating,

and thus preserving them. Investigations also have brought out a new type split-pole reinforcing collar which is proving a very successful substitute for the unsightly stub now in use.

Concrete has been studied in connection with every power development or other construction work undertaken by the Commission since 1918. The work has been enlarged to include masonry materials as well, i.e., brick, stonework and other types of construction. A subcommittee now supervises these studies devising tests to control the quality and strength of the resultant products. Prevention of deterioration in concrete has been one of the most important problems of this group and considerable succcess has been attained in developing methods for repairing eroded or otherwise damaged surfaces.

Paint, its quality and the manner in which it is applied, has been the subject of a great deal of investigation. Considerable work has been done also in determining the most satisfactory treatments for various surfaces before painting. The subcommittee on this work has been active in standardizing colours which has resulted in the use of uniform colour combinations throughout the Commission's plants.

In the studies of electrical insulation a new and very reliable method of test for live transformer and oil circuit breaker bushings has been devised. The deterioration of wood insulator pins has received considerable attention and the cracking of switch insulators due to thermal changes has been investigated. The

*The visit of the Research Subcommittees to the Laboratories, October 25th, 1938.*

studies also include insulator design, wood pin digestion and radio interference.

The subcommittee on Electric Welding is following closely advancements in this art, studying the best technique used and considering reliable methods of testing the finished welds. Methods of repairing the corrosion and wear in vanes of turbines and centrifugal pumps are now being studied. This group also is investigating the quality of pure weld metal deposited from the various rods which are used by manufacturers supplying equipment to the Commission, the important characteristics being tensile strength, ductility, impact resistance, and freedom from non-metallic inclusions.

Electric Soil Heating has been studied through co-operation with growers and with the Ontario Agricultural College, and the use of a special electrically-heated greenhouse at Niagara Falls. Suitable features of design for greenhouses and hot beds, and desirable types of heating units and their installation have been determined, and also the heat fluxes required, all of which information is now available to interested growers.

The remote control of loads has received considerable attention in study of the different methods of control and the equipment available on the market. A special street lighting relay has been developed by this subcommittee.

A study of various types of heating elements has been made and some special investigations carried out at the Laboratories on heating and cooking units.

A subcommittee on Petroleum Products is classifying oils and greases according to quality and utility and investigating factors responsible for their deterioration. This subcommittee has prepared specifications for generator lubricating oil and transformer insulating oil, endeavouring to standardize these products, thus to reduce the variety required to be purchased.

Attention has been given to means of reconditioning deteriorating insulating oils and satisfactory methods have been worked out resulting in several thousand gallons of oil having been refined in the field.

The subcommittee on Water Treatment has before it the problem of preventing corrosion in water tanks and cooling systems. The effects of operating temperatures and pressures as agents in accelerating corrosion are being investigated.

There are three additional subcommittees, recently formed, which are studying the applications of electronics to power systems, the making of connections and joints in conductors, and electrical grounding in system operation and for safety to life and equipment.

On October 25th, members of the active subcommittees visited the Laboratories and made a tour of inspection. They were given opportunity to see much of the equipment which is being used in the research investigations, and also some of the results obtained by their own and the other groups.

# Stars, Nebulae and Galaxies

FOR an observer with a portable telescope looking beyond the boundaries of the solar system, there is much of interest in the stars and nebulae. Early observers noted that the stars were very numerous, that they were very high and that they differed considerably in color and brightness. They form an excellent background against which the members of the solar system may be viewed, and here and there amongst them can be seen some of the nebulae,—those faint hazy patches of light about which little yet is definitely known.

*Fig. 1—The "Double-Double" Star in Lyra. The pairs are 207 seconds (of arc) apart. The left pair have 2.3 seconds, and the right 3.1 seconds, separation.*

### Double Stars

The stars appear to the eye just as points of light and, in general, look much the same in a telescope, but there are some stars which are of particular interest because, when sufficiently magnified, they are seen to be double,—two distinct points very close together,—and some are triple, or even quadruple.

Double stars may be such only apparently, that is, one star may be far beyond the other but the two are almost in line in our view of them. There are many beautiful colored pairs, their colors indicating their temperatures. Some "doubles" appear quite widely separated and even may be seen as two stars with the unaided eye.

One of the most interesting examples of these visual double stars is to be found in the constellation, Lyra. The eye can hardly see that there are two components but even opera glasses show them as a distinct pair. However, in a telescope as one increases the power, he finds that each of these components is itself a double star. This is known as the "Double-Double" Fig. 1.

Another type of double star is the binary system which consists of a pair that actually revolve around each other, and the periods of revolution of several of these pairs have been measured. The components are held together by gravitational attraction and they may be seen as definite pairs of stars which are equal in brightness, or differ considerably, and they may differ in color also.

In some double stars the components are too close together to be seen as separate points, even with a telescope, but spectroscopic measurements prove them to be binaries.

### Variable Stars

Several individual stars have been observed to vary in brightness. There

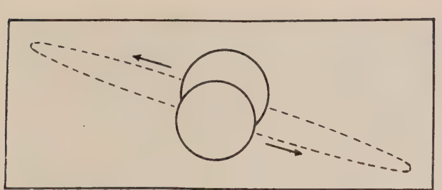


*Fig. 2—In the "Eclipsing Variable" Star, one component passes in front of the other. At that time their combined brightness will be a minimum.*

is first the temporary star, called a "nova", which appears unexpectedly, reaches a maximum in brightness, and then fades out and does not reappear. There are also irregular variables; they vary but do not fade out. Some other stars are periodic in their variations.

Of this third type, the "eclipsing variables" form the most interesting group. These have a normal brightness but periodically fade to a certain point and then recover. The graphs of their light variations, coupled with the periodicities of these changes, indicate that these are binary stars with components usually of widely different brightness,—one may even be a dark body,—and that these components pass one in front of the other thus producing an eclipse, as in a partial eclipse of the sun, at which times the observed brightness of the "star" is a minimum, Fig. 2.

### Star Clusters

The stars do not appear to be arranged in any definite order in the heavens. In the Milky Way, millions of stars are closely grouped. To the eye these appear hazy but, through a telescope, individual stars may be seen, Fig. 3.

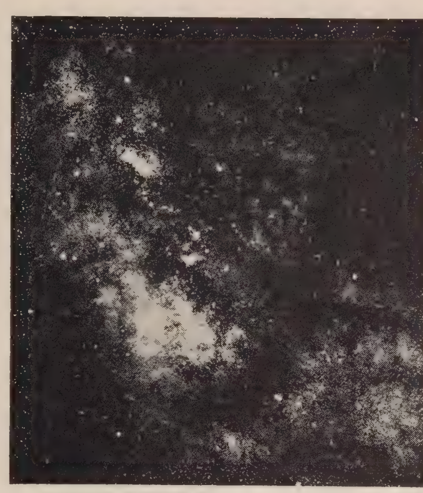


*Fig. 3—The Congestion of Stars in Sagittarius, one part of the Milky Way.—Mt. Wilson Observatory.*

There are numerous smaller clusters, many of which are quite well known, easily recognized and separately named, — the Pleiades, the Hyades, the Bee Hive, etc. A beautiful pair of irregular clusters, with stars of different colors, may be seen in the constellation, Perseus.

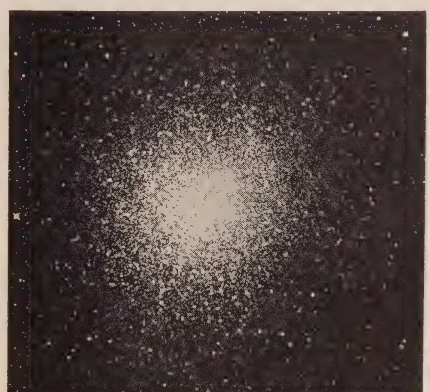


*Fig. 4—The Great Star Cluster in Hercules. (Exposure 11 hours).—Mt. Wilson Observatory.*

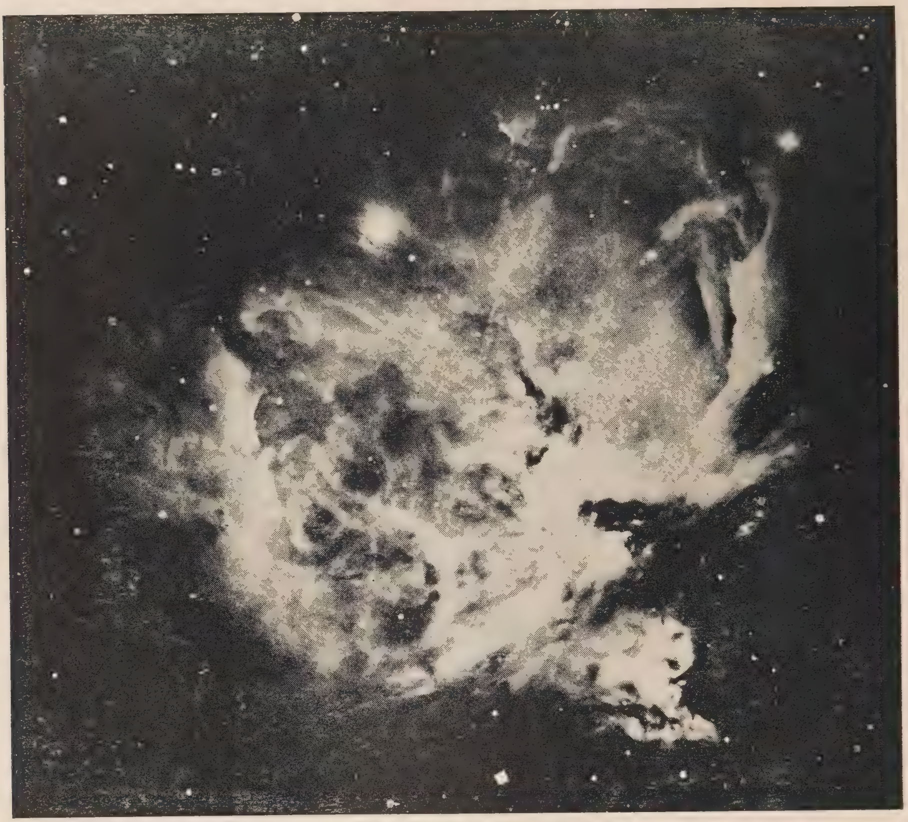


*Fig. 5—The Great Nebula in Orion.—Yerkes Observatory.*

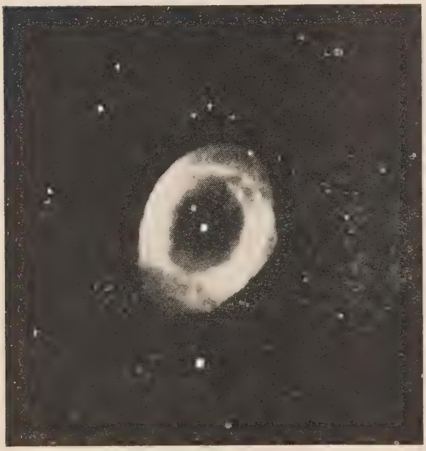


*Fig. 6—The "Ring" Nebula in Lyra. —Yerkes Observatory.*

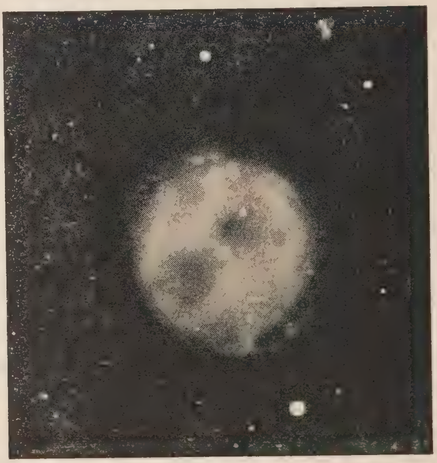


*Fig. 7—The "Owl" Nebula in Ursa Major.—Mt. Wilson Observatory.*

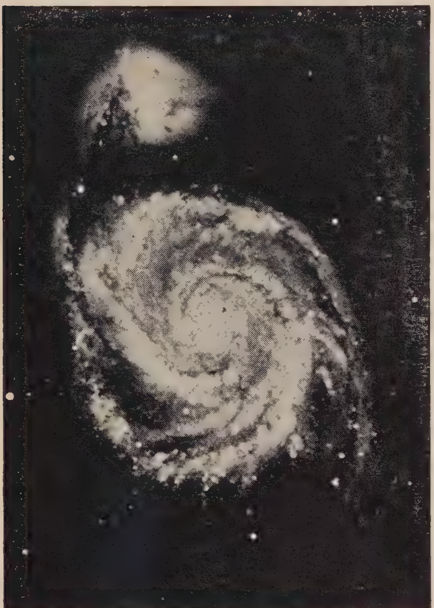


*Fig. 8—The "Whirlpool" Nebula in Canes Venatici.—Mt. Wilson Observatory.*

*Fig. 10—The Great Spiral Nebula, or Galaxy, in Andromeda. It is 930,000 light years distant.—Yerkes Observatory.*

*Fig. 9—A Spiral Nebula, on edge, in Andromeda.—Mt. Wilson Observatory.*

*Fig. 11—The Great Spiral Nebula, or Galaxy, in Andromeda. (Central Portion).—Mt. Wilson Observatory.*

One of the most remarkable globular clusters is found in Hercules. As far as is known, it consists of 75,000 individual stars of different magnitudes, Fig. 4. Through a small telescope, this cluster appears only as a blurred circular patch but the camera brings out its marvel.

### Nebulae

The faint and hazy nebulae may not be of great interest to observe. Some are reflecting the light of nearby stars whereas others are self-luminous but are shining partly by invisible ultra-violet rays so require the photographic plate to show their details.

Nebulae are classified according to shape,—

Nebulosity is found in the neighborhood of certain stars, being particularly noticeable in one cluster, the Pleiades.

### Our Galaxy and Others

By means of the spectrograph, the light from the distant stars is dispersed into its different color components and photographic records are made. Study and analysis of these spectra not only reveal the chemical elements present in the stars themselves and in their atmospheres but also give information from which the radial velocities of these stars are determined, i.e., the rates of speed at which they are approaching, or receding from the earth.

Stars in one part of the Milky Way are found to be travelling toward the earth,—or the earth travelling toward them,—whereas stars in the opposite part of the sky, also in the Milky Way, evidently are travelling rapidly away from the earth. Other stars, at ninety degrees from these positions, are neither approaching nor receding; they appear, instead, to be travelling with us. From these results, it is now thought that the stars we see form one great galaxy, or grouping of stars, which is revolving around some fixed point in space, our sun being one of these stars, and the whole arrange-

| *Type* | *Example* |
|---|---|
| Amorphous, diffuse, or irregular | —The Great Nebula in Orion, Fig. 5. |
| Ring | —The "Ring" Nebula in Lyra, Fig. 6. |
| Planetary | —The "Owl" Nebula in Ursa Major, Fig. 7. |
| Spiral | —The "Whirlpool" Nebula in Canes Venatici, Fig. 8. |
| | —A Spiral Nebula in Andromeda, appearing on edge, Fig. 9. |
| | —The Great Spiral Nebula, also in Andromeda, Figs. 10 and 11. |

ment being somewhat like a flat disc, or watch case, but bulged at the centre.

As we look then in any direction in the plane of this disc, we see multitudes of stars,—i.e., the Milky Way right around the heavens,—whereas when we look elsewhere, as looking through the disc, the stars are not nearly so many nor so congested. From this it would appear that the Milky Way is the outer part, or main disc of our great revolving galaxy.

At various points in the sky, and at great distances, we find the so-called spiral nebulae, Figs. 8, 9, 10, 11, which now are thought to be other galaxies of stars, similar to our own, and each revolving around its own particular centre. The shape of these galaxies, if such they be, show that this arrangement of stars is possible. Thus they seem to confirm the modern conception of our galaxy, and to reaffirm consistency in the system and order of this Universe.

BEYOND—?

The nearest star is about 273,000 times as far away as the planet Neptune, which itself is 3,000,000,000 miles from our sun. The most distant star is many thousand times as far as the nearest one. Still further out are the nebulae and the other galaxies and, beyond them, is infinite distance, infinite space,—but here we must stop for the human mind cannot comprehend the infinite. —F. K. D.

# Association of Municipal Electrical Utilities

## Nominations for 1939

THE Scrutineers' report on the primary ballot of the Association of Municipal Electrical Utilities shows the following nominations for the various offices for the year 1939. These names are listed in the order of the nominating votes received by each. Where a person is nominated for more than one office the by-laws of the Association rule that the office showing the greater number of votes shall be given precedence. The nominations are subject to the wishes of the nominees, but the names marked with an asterisk (*) are those which according to the scrutineers' report would appear on the election ballot, providing there are no withdrawals.

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W. M. Salter*, R. S. King*, C. E. Brown, R. D. Boyes, S. R. Belfry.

The election will be held at the winter convention of the Association on February 7th and 8th, 1939. Ballots will be distributed during the first morning of the convention, namely—February 7th, and up to the opening of the session on the afternoon of that day. The results of the election will be announced before that session closes.

O. M. E. A. and A. M. E. U.
CONVENTION

at the Royal York Hotel, Toronto
February 7 and 8, 1939

# THE BULLETIN

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# Power Development at Niagara

By Engineers of the Hydraulic Department, H.E.P.C. of Ont.

THE development of water power for industrial purposes and for the convenience of the home has been a problem which has keenly interested men during the past half century. To all who have gazed upon the great falls at Niagara there has undoubtedly come an intense appreciation of its beauty and grandeur, and to those of a utilitarian frame of mind there has developed a realization of the might which the falls possess.

The coincidence of the existence of such a tremendous natural workman and the growing requirements of a concentration of population within the vicinity must have forcibly impressed those men of Ontario and New York State who were to become the leaders in the campaign for the harnessing of water in the interest of human convenience. It was quite natural then that they should early turn to the Niagara river as a source of energy.

## Geography of the River

Whether considered with regard to its importance in the drainage system of the Great Lakes, to its value as a source of power, to the scenic attractiveness of its falls, rapids and gorge, or to its complicated and fascinating geologic history, the Niagara river is one of the most important and interesting streams in America.

A glance at a map of lake Erie and the Niagara river discloses the fact that the north-easterly quarter of the lake narrows uniformly as it approaches its outlet and merges into the river. At this point the water surface is normally 572 feet above sea level and the river, which is 20 to 30 feet deep in places, has a swift uniform current. As the outlet of lake Erie, the river, with a mean flow of about 200,000 cubic feet per second, carries the discharge of the upper four Great Lakes, except for diversions through the Chicago, Welland and New York State canals, and it has a

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**Vol. XXV No. 12**
**December, 1938**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

descent of 326 feet to lake Ontario.

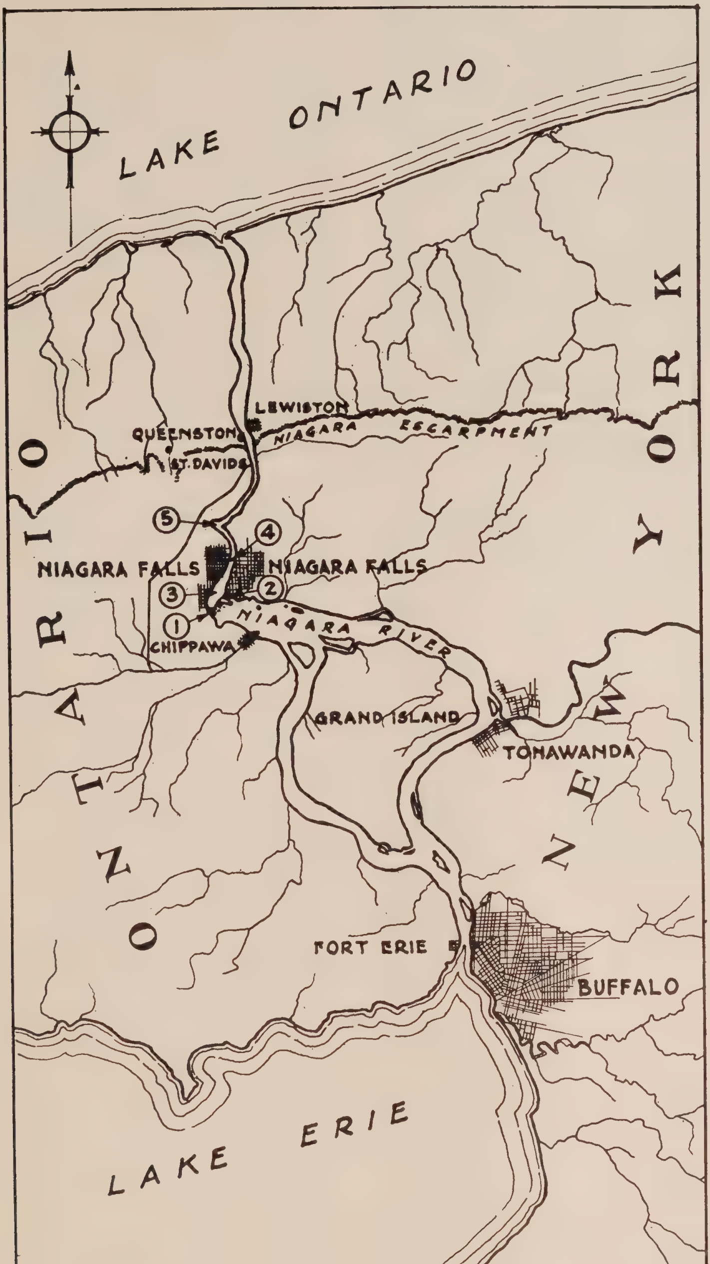
At Fort Erie the water passes over a rock ridge and through a comparatively narrow channel in which the water flows swiftly and with a fairly steep gradient. This ridge, just below the outlet of the lake, acts as a weir and fixes the relation between water surface elevation of the lake and outflow therefrom. As the lake rises, the outflow increases; as it falls, the outflow is reduced.

Below this control section the channel widens until it forms a broad expanse divided into two deep channels of varying width on either side of Grand island, which later unite below the island to form the Chippawa-Grass Island pool, which is nearly two miles in width. Throughout this portion, some eighteen miles in length, the river is a tranquil stream with low velocity. Immediately below the Chippawa-Grass Island pool the river breaks over the ledges of rock at the crest of the upper rapids.

At the head of the rapids the river has a width of 4,100 feet and is relatively shallow, except near the Canadian shore, where its depth is 9 or 10 feet in places. From lake Erie to the first cascade at the head of the rapids the river surface falls 13 feet, and it is worthy of note that in this reach the river bottom is in many places lower than the rock ledge which marks the head of the rapids.

At the first cascade the river is divided by Goat island into two unequal channels, which re-unite in the gorge below the falls. The northern or American channel, at first only 400 to 500 feet broad, widens to 1,000 feet at the crest of the American falls, where it plunges down the side of the gorge. Its channel is broken by several small islands, one of which, at the brink, named Luna island, divides the American falls into two parts having widths of 800 and 100 feet respectively, the smaller one being commonly known as Bridal Veil falls. The descent from the head of the rapids to the crest of the falls is 46 feet, and the stream is shallow and turbulent. The average depth is probably not more than 18 inches and approximately five percent of the river discharge follows this channel.

The height of the American falls above the level of the river below is




*Niagara river and vicinity. Legend:—1, Horseshoe falls; 2, American falls; 3, Maid of the Mist pool; 4, Whirlpool rapids; 5, Whirlpool.*

167 feet, but the water does not plunge directly into the river, dropping only about 100 feet onto a bed of great limestone blocks heaped irregularly against the base of the cliff and extending outward 200 feet or more.

The main channel, which flows south of Goat island, decreases in width from 3,200 feet at the head of the rapids to 1,200 feet between the walls of the gorge at the brink of the Horseshoe falls. Several small islands lie close to the south shore of Goat island, just below the head of the rapids, and numerous rocks project here and there above the surface of the water. Except in the main channels, which are 6 to 12 feet deep, the water is shallow, particularly on the rock shelves which adjoin Goat island and the Canadian shore. The descent from the cascade at the head of the rapids to the brink of the falls is 50 feet.

The outline of the Horseshoe falls is rather irregular and is convex upstream to the extent that the apex of the deep re-entrant was in 1927 about 850 feet upstream from a line joining the ends of the falls. The height ranges from 158 feet at the Goat island shore to 161 feet at the apex of the curve.

Except for a few hundred feet adjoining the island, where there is a deposit of limestone blocks similar to that at the base of the American falls, the water plunges directly into the great pool at the head of the gorge, the surface of which is a mass of foam in continuous turmoil for some distance from the foot of the falls.

Immediately below the falls the river enters the gorge of Niagara, extending for seven miles from the Horseshoe falls to Queenston and Lewiston. The first two and one-quarter miles of this, from the falls to the beginning of the Whirlpool rapids, is known as the Maid of the Mist pool and is navigable for the greater part of its length. There is a fall of about five feet in this distance and, except close to the falls, the water surface is smooth and the velocities moderate. The bottom is very irregular and, while the depth ranges generally from 100 feet to a maximum of 192 feet, there are many places where masses of broken rock reach nearly to the surface.

The stream then narrows to an average width of about 350 feet for a distance of about three-fourths of a mile. This section is known as the Whirlpool rapids and is rather shallow and very turbulent, with great waves standing here and there which present a most impressive spectacle. The descent here is about 50 feet and the velocity of the current is in places over 30 feet per second.

Immediately above the whirlpool the channel widens several hundred feet and the velocity of the stream is somewhat checked, but speeds up again at the entrance to the whirlpool, where it rushes past the outlet to the far side of the pool, makes a complete circuit to the left and, diving beneath the incoming water, comes up again at the outlet, which is a narrow gateway in the rock wall about 400 feet across, through which the water pours in a swelling torrent several feet higher in the centre of the stream than along the shores. The whirlpool is about 1,700 feet long and 1,200 feet wide,

and soundings disclose depths up to 126 feet.

The width of the stream in the next section, through the Lower Great gorge, varies mainly between 400 and 800 feet. An intermediate section, opposite Niagara Glen, has a width of only 300 feet, and here the river is shallow and turbulent. This part is known as the Foster or Devil's Hole rapids.

Below this the river ranges in width from 400 to 800 feet and increases to depths of 150 feet in places, while its velocity and turbulence gradually die away to comparative placidity. At Queenston the river emerges from the Niagara escarpment, and attains a width of 2,000 feet, which it retains to the outlet into Lake Ontario. It is of interest to note that the bottom of the river throughout the gorge, except at the Whirlpool rapids section, is below the surface level of lake Ontario.

### Geologic History

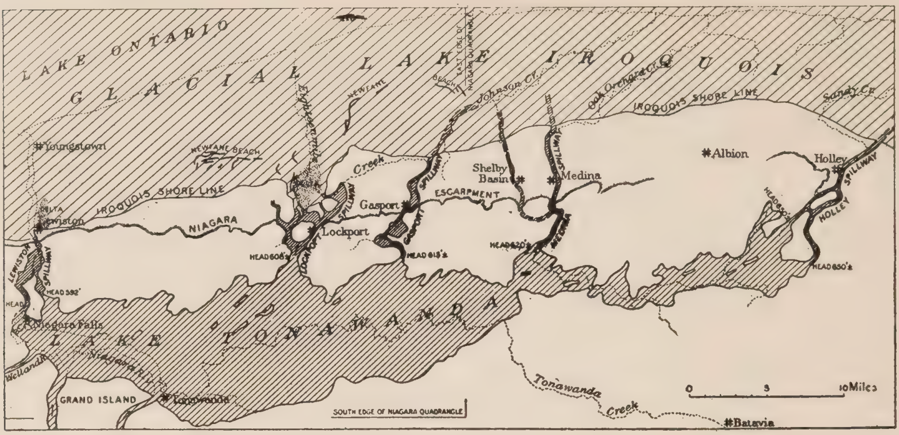
The geologic history of the formation of the Niagara gorge comprises a subject of intense interest and of a magnitude far beyond the scope of this paper. A brief outline, however, may be of value in creating a background for the physical features which have just been described.

During the very early eras, that part of the country surrounding Niagara Falls was for a great period of time submerged under sea water, and the region was covered by successive sheets of pebbles, sand and clay which were carried down and deposited by streams from the neighbouring land. At times beds of limestone and other formations were precipitated over the sea bottom. The waters teemed with sea life, and in some beds the remains of various forms of invertebrates, having calcareous shells, are preserved in numbers so great as to form an appreciable part of the rock. It was during this period that the various strata, now clearly exposed in the walls of the Niagara gorge, were deposited. A rise of the land level later caused the recession of the sea water and left the region exposed and subject to the normal processes of erosion.

The great ice fields of the glacial ages were a later visitation upon the territory, moving in a south-westerly direction across the Niagara peninsula, levelling off the hills and filling certain valleys to such an extent as to alter the course of the natural drainage. The Niagara valley itself was at this time so filled with glacial deposit that an old course from the present whirlpool north-westerly toward St. Davids was thus permanently blocked. Ages later it was the scouring action of the modern Niagara river upon the exposed face of this old channel, with its comparatively loosely compacted glacial debris, which created the bay in which the whirlpool, as we see it, makes its rounds.

Near the close of this particular epoch, when the ice had melted out of the region, the land was so much depressed that the present lake Ontario was a sea, connected with the ocean by the gulf of St. Lawrence, which then extended that far west.

With the retreat of the ice, glacial lakes covered the territory, of which three are of particular interest to our subject. Lake Lundy filled the



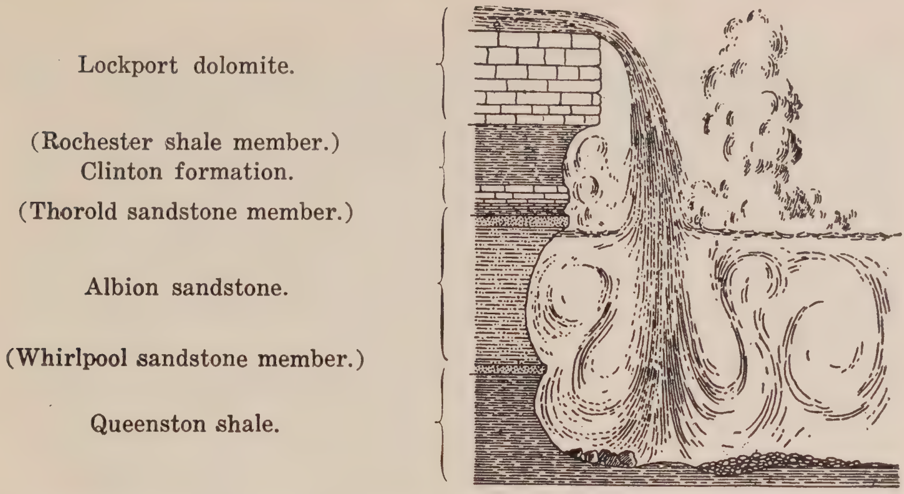

*Sketch map showing lake Tonawanda and spillways from it to glacial lake Iroquois.*

The lower or early stage of lake Iroquois, into which the spillways emptied, is partly indicated by the Newfane beach. The shore line of lake Tonawanda is approximate, as it has been accurately determined in only a few places. Present elevation above sea level of heads of spillways is given.

southern part of lake Huron, the whole of lakes Erie and Ontario, and the surrounding territory. Later, lake Tonawanda filled the present Tonawanda valley and extended for more than 500 miles eastward from Chippawa and Niagara Falls. The third of these great bodies of glacial water was known as lake Iroquois, and filled the present area of lake Ontario and the bordering lower lands.

Fragmentary remains of beaches give the student of geology an estimate of the water levels at which these lakes formerly stood. Lake Lundy is thus indicated to have been at an elevation varying from 650 to 790 feet above sea level. Lake Tonawanda is likewise found to have existed at a level of about 590 feet above sea level, while lake Iroquois beaches, which are rather well defined, are situated at an elevation in the neighbourhood of 400 feet above sea level, a level which was maintained by a surviving ice blockage across the St. Lawrence valley, during the existence of which the lake discharged through the Mohawk valley to a marine estuary in the valley of the Hudson.

Subsequently, the draining off of the waters of lake Lundy exposed the high plain south of the Niagara escarpment, which formed a barrier between lake Tonawanda and the lower lake Iroquois. It was at this phase in the geologic history of the district that the present Niagara river had its birth. The escape of the waters of Tonawanda lake to the lower water surface of lake Iroquois, across the separating barrier, created at first five separate spillways, of which the Niagara river was one. Through

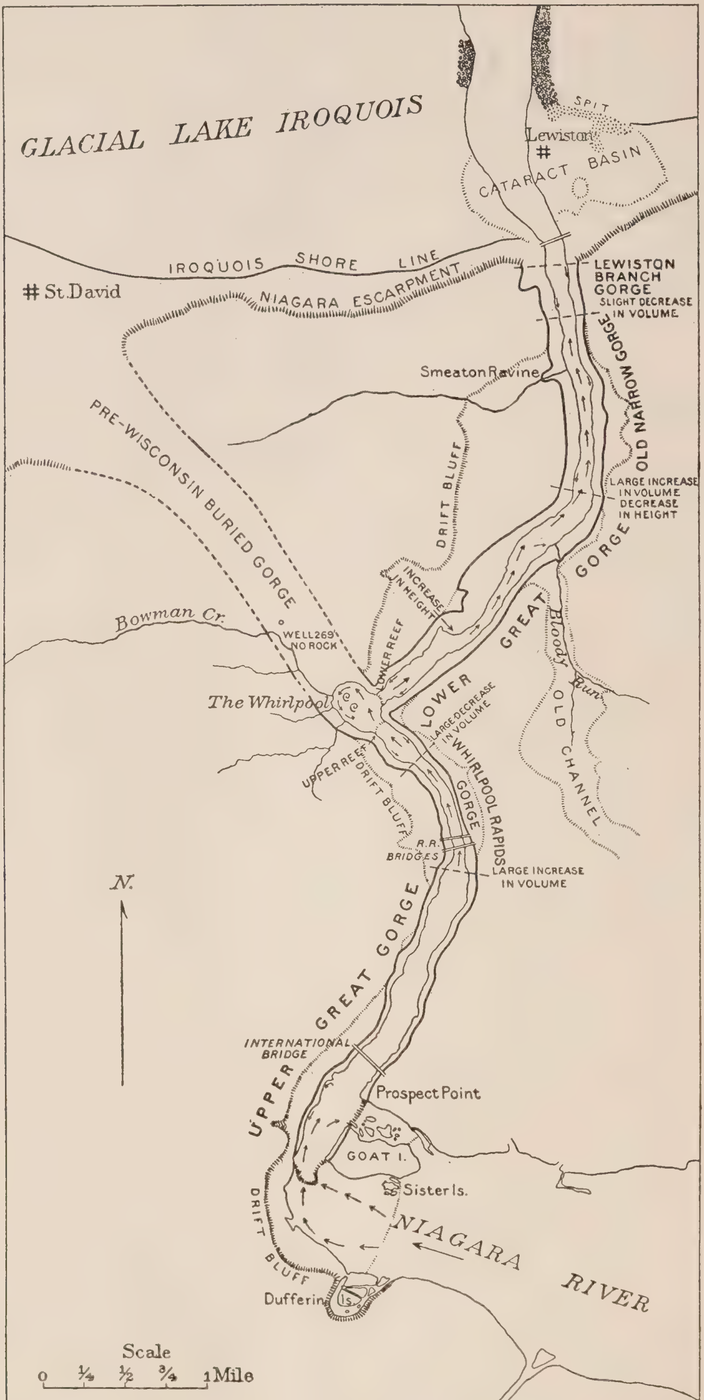



*Section of brink of Niagara falls showing the arrangement of hard and soft strata and illustrating the process of erosion.*
Scale, 1 inch = 160 feet.

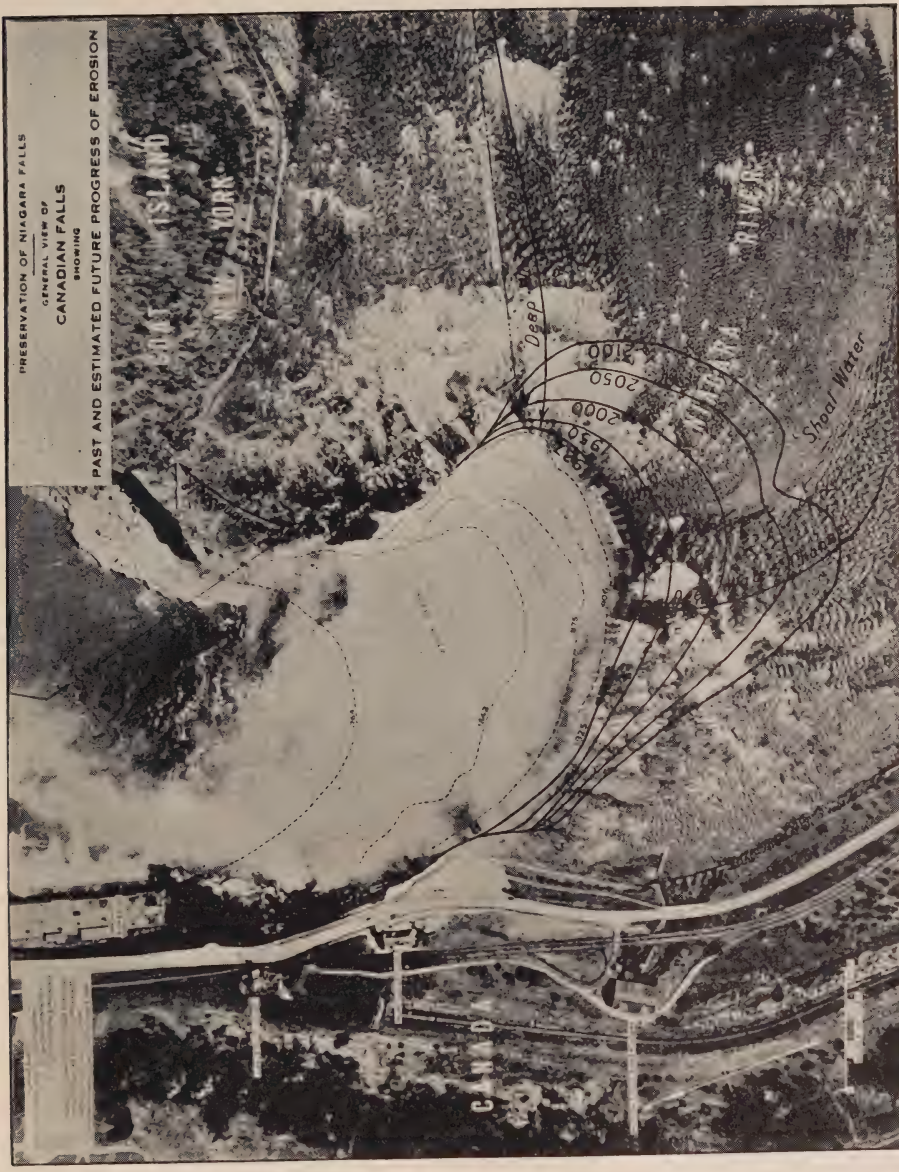
early erosion, and due partly to a tilt of the whole district toward the south-west, the Niagara river soon became the major course for the water flowing between the two lakes. This was the beginning of the present Niagara river and of the gorge which now extends nearly seven miles back from the escarpment.

The scouring out of the great depths of gorge which characterize the Niagara river clearly points to the action of some process other than normal erosion and is explained by a knowledge of the various strata which underlie the river. A vertical section through the rock face at the present falls shows that at the surface the river bed is paved with a layer of hard dolomite, 80 feet deep, beneath which there predominate strata of sandstone and of Queenston shale. In the process of erosion under these conditions there always exists an overhang of rock highly resistant to scour, over which the water falls in a vertical drop to eddy back against the comparatively soft underlying strata. The wearing away of this material is greatly accelerated by the abrasive effect of great blocks of surface material which are thrown against its face by the swirling waters.

In this manner the cutting of the great gorges, each comparatively narrow but reaching depths of 500 feet or more, has progressed from the northerly face of the escarpment back up the stream to the present falls. Study of the plotting of successive surveys during modern times has indicated that a mean rate of recession of the falls face is in the neighbourhood of four feet per year. The age of the falls has likewise been estimated to be about 35,000 years.




*Sketch map of Niagara gorge showing the five named divisions of the gorge.*




### History of Development

The development of power at Niagara Falls, which is the principal source of energy for the Niagara system, has presented many interesting aspects. Omitting any reference to the technical difficulties and early doubts as to the feasibility of transmitting power for utilization at any considerable distance, there remain special features of the early developments on the Canadian side which

are still exercising an influence on the practical problem of supply.

Under the terms of the Boundary Waters Treaty between the United States and Canada each country is authorized to divert a fixed quantity of water. Canada is entitled to take a daily average of 36,000 cubic feet per second, while the United States is entitled to a daily average of 20,000 cubic feet per second.

The Commission's first power supply was obtained from the Ontario Power Company in 1910, under a purchase contract. The demand for energy grew rapidly and in 1917 the Ontario Power Company was acquired, followed by the purchase in 1922 of the Electrical Development plant of the Toronto Power Company. These plants utilize only a part of the head available, as will be more fully described later. In 1917 construction of the 500,000 horsepower Queenston development was commenced, and by 1922 power first became available from it.

As the Queenston plant, which did fully utilize the economically available head between lake Erie and lake Ontario, approached completion, the apportionment of water among these three Commission-owned plants became a matter of considerable importance. The Toronto Power plant, which was capable of producing approximately 9½ horsepower per cubic foot per second, being the least efficient of the three, had to be used as little as possible; the Queenston plant, which produced 29½ horsepower per cubic foot per second, roughly three times the amount of energy for the same quantity of water, had to be loaded as continuously as possible; while the Ontario Power plant, which stood in an intermediate position and produced 17 horsepower per cubic foot per second, had to take as much as possible of the load which could not be carried by Queenston.

### Factors to be Considered

The axis of lake Erie, lying south-west and north-east, is often directly under the path pursued by the low-pressure areas that pass across the continent at intervals of about three days. The passage of one of these areas along or near the lake may set up violent wind storms and variations in pressure from end to end of the lake surface that cause the water to rise at one end and fall at the other. For example: during a storm on December 8th, 1927, the lake rose to elevation 579.8 at Buffalo and fell, at the same time, to elevation 564.5 at Toledo. The normal elevation of the lake at that time was 571.4, so that at the west end it was about 7 feet below normal, and at the east end 8 feet above normal level. The immediate result of such a high elevation as this at Buffalo is a large increase in the flow of the Niagara river. Such extreme stages are not of great duration. In winter they may result in great amounts of ice being driven into the river and, as the immediate sequel to a high stage caused by wind is often a low stage with consequent low flow, the river channel may become gorged with ice, which endangers structures along its banks and hinders the efficient operation of the power plants which draw their water supply from

the river. The upper river channels, however, in general, have much greater carrying capacity than the narrow gorge below the falls, and serious ice jams have formed in this latter section much more frequently.

The significance of these river characteristics in connection with power development may be considered under two headings: firstly, with respect to concentrations of head and, secondly, with respect to permissible diversion, as these are controlled by scenic considerations and ice transportation.

The power developments that were constructed about thirty to thirty-five years ago, including the Ontario Power and the Toronto Power plants, were all located close to the falls and used only a portion of the head available in the whole river. To use all that might have been developed would have involved the construction of long and expensive water channels. It is doubtful if these could have been financed at that time; in fact the first power canal on the American side of the river was a financial failure, although it did not involve an expenditure comparable with what is involved in a full development of all the available head in the river. The Ontario Power development was, in some respects, the boldest of the projects built at the beginning of the century, as it involved the construction of a large conduit well over a mile in length and utilized the head in the upper rapids and the falls. Other developments on the Canadian side utilized only a part and, in some instances, a small part of this fall.

At first sight it might appear that the choice as between developments of the Ontario Power type on the one hand and the Queenston type on the other, could be determined by economic considerations alone. This is hardly the case.

The questions of the preservation of the scenic beauty of the Niagara falls and rapids and of the transportation of ice from lake Erie to lake Ontario have been the subject of investigations and studies for many years by experts from various governmental and private organizations, in order to determine what effect the diversion of water would have upon the appearance and ice-transporting capacity of the river. Advantage has been taken of those periods of low water, such as occur at intervals of several years and of those following the sudden reduction in flow due to wind on lake Erie, to estimate the importance of the various factors. One of the most important of the investigations carried out was that of the Special International Niagara Board who, reporting in 1929, indicated that in their opinion increased diversions could be made around the Niagara falls without impairment of the scenic effect contingent on the construction of remedial works above the crest of the falls to give a more uniform distribution of flow. This report also indicated that a greater diversion could be made around the Niagara falls than would be permissible from the lower rapids and that, in the case of the falls themselves, diversions approaching 100,000 cubic feet per second might be permissible, while diversions in the

lower rapids might be limited to 70,000 cubic feet per second.

From this then it will be seen that, while the most efficient use of the water available for the development of power would be secured by utilizing all the water in a development of the Queenston-Chippawa type, in order to meet the requirements of scenic effect and ice transportation there will always be the development of a considerable amount of power in the immediate vicinity of the falls to make use of the greater diversion permissible at that point as against the diversions which might be allowed from the lower river.

Thoughtful consideration of the processes of nature all down through the ages, which have provided for our use the means of supplying our cities and rural districts with the benefits of modern electrical service, perhaps leads us to a better understanding of the words which are borne by the Commission's official crest *"Dona Naturae Pro Populo Sunt"*—the Gifts of Nature are for the People.

* * * *

In connection with the source and verification of parts of the data used in this paper, the writers wish to make appreciative reference to the following publications:

Geologic Atlas of the United States, Niagara Folio, published by the United States Geological Survey.

Diversion of Water from the Great Lakes and the Niagara River, Colonel J. G. Warren, United States Corps of Engineers.

The Preservation of Niagara Falls, Final Report of the Special International Niagara Board.

# The Electrical Way of Living

By one slight touch my hand controls a force
That does my bidding to perform my tasks.
In former days men only saw the streak
That flashed forth from the storm with crashing sound.
The secret, now revealed, lights up my home,
Brings warmth to temper winter's chilly blasts,
Preserves my food, prepares it for my meal,
Makes clean my garments, smooths and softens each,
Removes the dust that gathers in my house.
Nor is this power mere slave to save me work,
By it I hear the music from afar,
The march of world events to me is known.

F. G. KIRKPATRICK.

# Double-Circuit, 110,000-Volt, 25-Cycle Tie Line

## Through the City of Toronto From Leaside Transformer Station to Strachan Avenue Transformer Station

By A. E. Davison, Transmission Engineer, H.E.P.C. of Ontario

GATINEAU power first came to The Hydro-Electric Power Commission of Ontario from Quebec in the Fall of 1928, at which time a 220,000-volt terminal station was located in the northeast part of the metropolitan area of Toronto, immediately south of the C. P. R. station at Leaside. From this station, a double-circuit, 110,000-volt line was carried westerly along the Canadian Pacific railway to the "Bridgman-Davenport" 110,000-volt station which had been served from the Queenston area some time previously. This service from the west made use of four existing circuits purchased from the Toronto-Niagara Power Company in 1922, and which were equipped with rigid "pin type" insulators. This construction extended to the Islington area, from whence a tie line had been built southerly to a point on existing Niagara system circuits near the Commission's York station in Etobicoke township. These original (1911) circuits came from the west, passing York station, thence to the Toronto city limits and to a "Strachan Avenue" site east of the Canadian National Exhibition grounds.

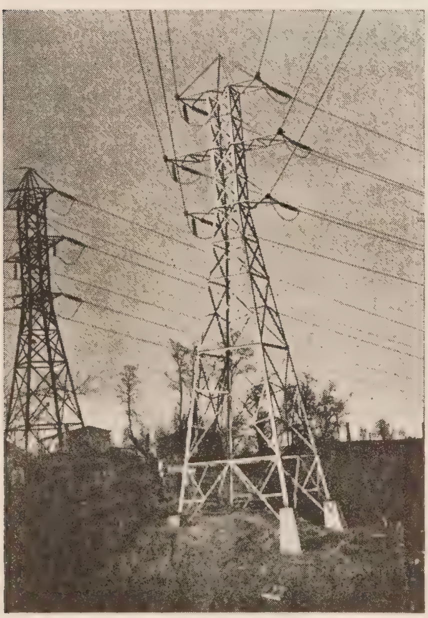
Latterly it was decided that a tie line should be erected from the above 220,000-volt terminal station, generally southerly down the Don river and then westerly along the waterfront to the Strachan Avenue terminal station, thereby creating a loop (see chart) which would materially improve service to the various districts of the Niagara system.

Surveys were made and rights negotiated so that construction could be started on this tie line on the 2nd of August, 1938. The line was put in service on October 31st, having been tested out during the previous week.

Materials and finished parts used in the construction of lines of this type are now practically all produced and fabricated in Canada. Only minor supplies of comparatively special structural sections for the towers need to come from abroad and these generally only to speed up deliveries.

Matters peculiar to the district, and special auxiliaries required because of local conditions, centered around the fact of railway occupation. Foundations were greatly affected by existing underground conditions. Attention had to be given to the communication services of the railway,

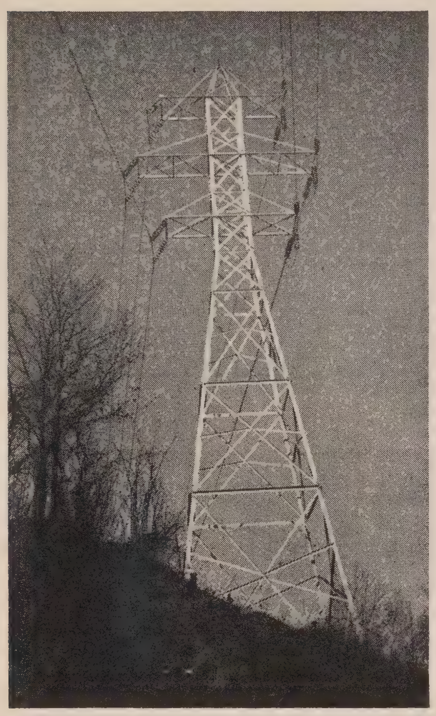

*Map of Toronto and vicinity showing 110 kv. loop connecting the high tension stations.*



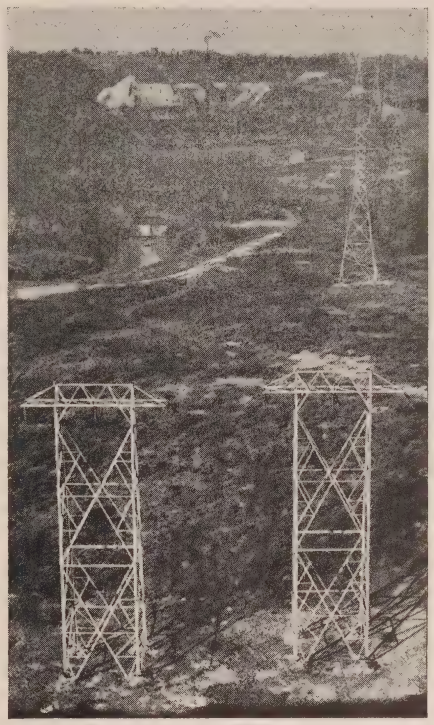
*Double circuit towers of the 1928 (left) and 1938 (right) lines leaving Leaside.*

including radio broadcast circuits. Lead-covered cables were laid and modern terminals installed, so that the susceptiveness of these circuits to disturbances outside of those originating within the communication circuits and works is reduced to a minimum. Proximity to a smoke nuisance which reduces the efficiency of electrical insulation and also to neighbouring radio listeners, the more susceptive of which are sometimes interfered with when insulation is inefficient, was also given attention. The westerly portions of the line are near the gliding areas of a proposed airport; they are, however, in practically all cases, below the skyline of the area.

For the electrically-dead "ground" cable which is located well above the six power cables on the tower, a copper-covered steel conductor of greater



*Double circuit angle tower in Don valley using "dead-end" construction on outside and double insulation on inside of angle.*

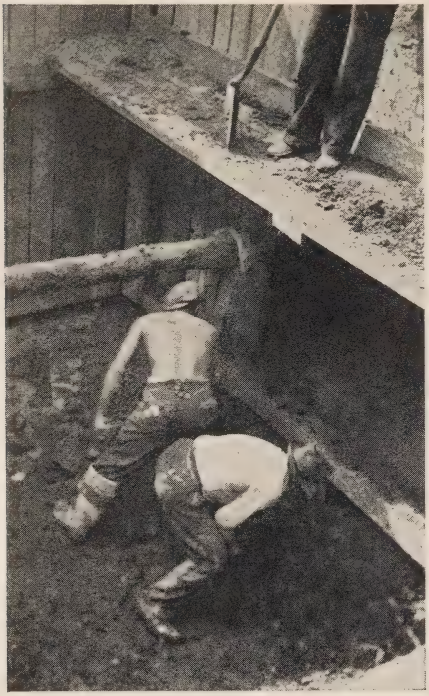


*Single circuit towers at Danforth Avenue with a number of double circuit towers in background.*

than ordinary mechanical strength was used. Copper conductors were installed from the steel footings, through the concrete footings, to earth so as to discharge air-earth electrical currents, if any, without damage to the circuits or to surrounding property. The six electrical conductors have an outside diameter of a little less than one inch and are referred to as "605,000 circular mil aluminum steel-reinforced cables." Fifty-four aluminum wires are stranded in three layers over a central core of seven steel wires.

When construction is commenced on a project of this sort through a suburban area, one soon discovers that a city like Toronto has its roots quite deep in the earth. It was exceptional to open a foundation in original earth. Sewers, pipes, drains, fill, garbage dumps, and what-not were the order of every day's work.

At least two rather interesting experiences arose in connection with the foundations. On what is now private property, a little to the west of the existing Strachan Avenue, excavations disclosed a series of railway ties and some old railway fish plates (36 or more inches long), which were largely in place and intact, some six to eight feet below present ground

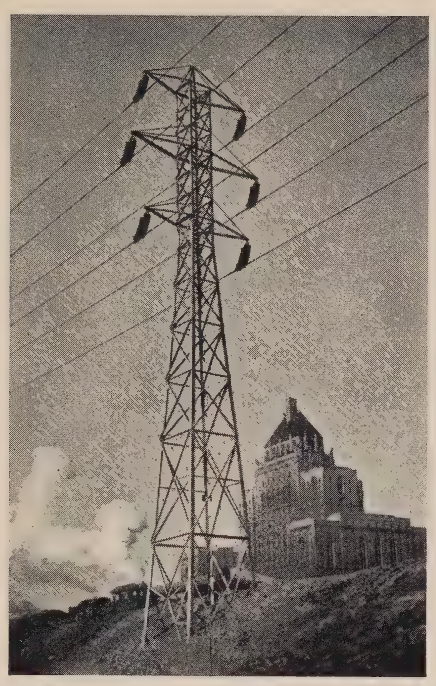


Excavation work for tower footings along Don river.

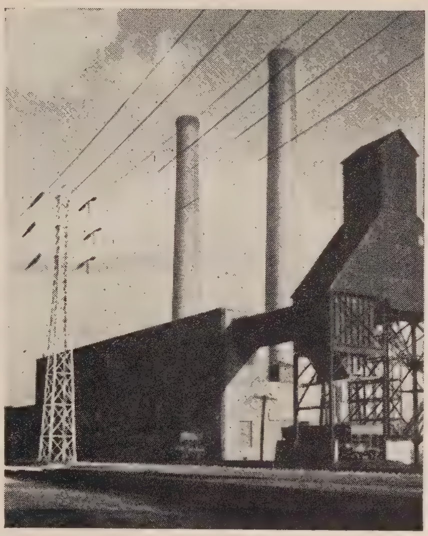
Towers are generally insignificant against the skyline of Toronto waterfront.

Tower on waterfront with Royal York Hotel in background.

Double circuit transmission line on Toronto Terminals Railway Co. viaduct looking west from near Fleet and Rees streets. Toronto Hydro-Electric System feeders in foreground.

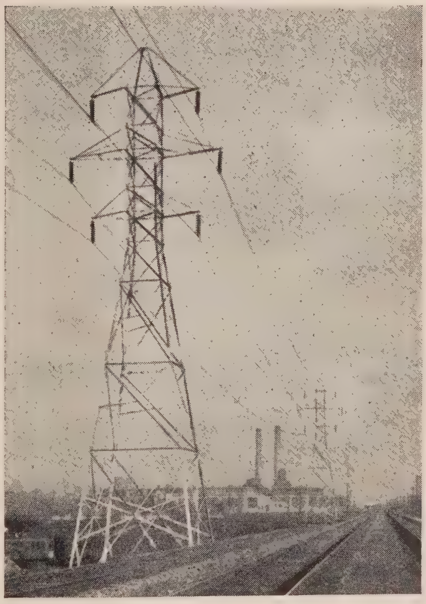


*Double insulation tower on side of viaduct near Bay street.*



*Transmission line passing steam plant of Toronto Terminals Railway Company.*

level. These were evidently a part of the original electrically driven street railway to the Exhibition grounds, operated first on September 11, 1886, and sometimes spoken of as the first electric railway in North America (see *The Bulletin*, page 318, September, 1936). Excavations for another tower, located east of Bathurst street, disclosed at a considerable distance below the present ground level parts of the old Queen's wharf. These timbers were particularly well preserved. This wharf is probably still, so far as history is concerned, the most famous wharf in Toronto, having been in use over a quite long period, and having given at one time service to a great many commercial



*Double circuit wide base towers on Toronto Terminals Railway Co. viaduct looking east from Spadina Ave.*

sailing ships of the old stone-hooker days. Other unrecorded underground structures and works encountered include a wood drain, still operating but not well charted, near the Don river, south of Gerrard street, gas and waterpipes at six towers north of Gerrard, north of Queen street, and east of York, and sewers at two towers immediately east of Bathurst street.

Monolith concrete footings were used in a few cases. It was found desirable and economical to construct the quite deep (in some cases fifteen feet) concrete bases with hollow cores. It is expected that no trouble will arise from frost, as the concrete box is well reinforced and drained on opposite sides.

In addition to the usual danger and warning signs attached to the towers, a number of structures, especially where they are on alleys or on public (park) lands, have been equipped with guards, usually about twenty-five feet from the ground, to stop trespassers.

Special steel traffic guards have been installed at ground level and the towers have been suitably painted for protection wherever traffic, usually slow moving in all the areas, might come in contact with the structures.

Lock nuts and vibration absorbing mechanisms, excepting armour rods supplied by the manufacturers of cable, were not installed. This line is quite subject to inspection and will be watched for developments due to vibration.

In this comparatively short seven-mile line, some 530 tons of galvanized steel, 11 tons of reinforcing bars, 233,700 pounds of steel-reinforced aluminum cable, and 530 cubic yards of concrete were used. Approximately 8,500 manhours of labour were involved.

The steel towers were fabricated at Windsor, Ontario. The aluminum cable was produced in Quebec, largely at Shawinigan Falls.

The work was carried out by the construction forces of the Commission under the direction of David Forgan, the field work having been largely supervised by William McKenzie. Engineering details, surveys, field practice and inspection were worked out chiefly by A. C. Goodwin, C. A. Smith, W. E. G. Taylor and Frank Willsie of the Engineering Department of the Commission.

It is hoped that this line, although nearly three times as long, will have as good an operating record as the first centrally located tie line along the C. P. R. from Leaside to the Bridgman-Davenport station operating for ten years, and has never been off load because of trouble within the circuits.

The accompanying reproductions of photographs give an idea of the completed line.

# Interest in Astronomy

## By F. K. Dalton, H.E.P.C. Laboratories

*"The contemplation of celestial things will make a man both speak and think more sublimely and more magnificently when he comes down to human affairs."—Cicero.*

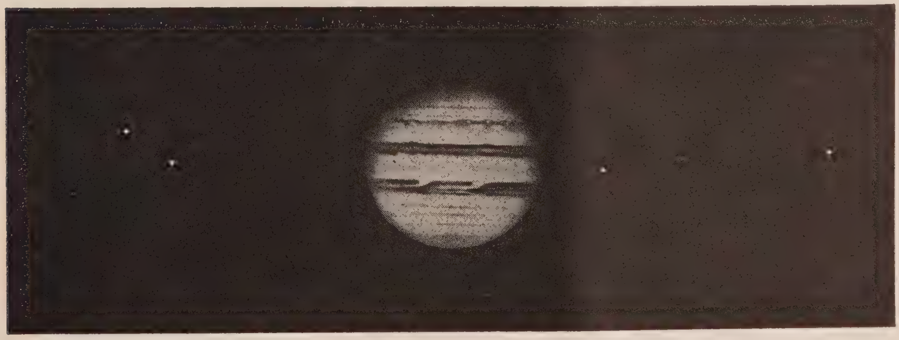
DURING the past three and one half years, a series of twenty articles on astronomical subjects has been appearing in *The Bulletin.* These have been prompted by observations of the heavenly bodies, and a desire to draw attention to the most interesting features, and their significance, as one may see them with, or without a telescope.

The heavens present a continuous drama of events. There are the summer and the winter stars and their constellations, with the planets, the "wanderers", being found in different positions each year. The sun has its regular motion of rotation, and so has the moon, but the latter is constantly changing its apparent shape. Then, to add further variety, a few comets visit us each year and create a certain amount of excitement.

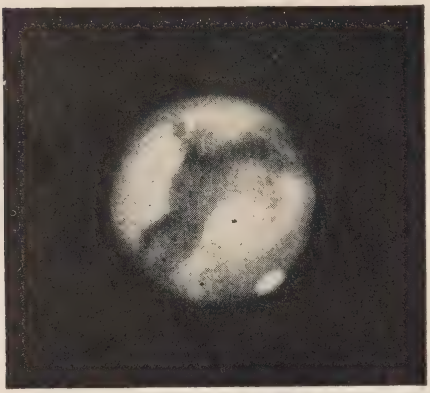
In the history of Astronomy, there have been many interesting events. The early "watchers of the sky" discovered nearly all of the phenomena which may be seen without the aid of a telescope, and they placed upon them their own interpretations. When later observers advanced theories which conflicted with the earlier conclusions, the power of religious belief prevented the acceptance of these theories. As facts came to be proven, however, they were received, but with considerable hesitation, and traces of the viewpoints of earlier days may even yet be found.

The observations, experiments and calculations of Copernicus, Kepler and Newton brought order out of the conflicting thoughts, and a clear understanding of the laws governing the movements of celestial bodies.

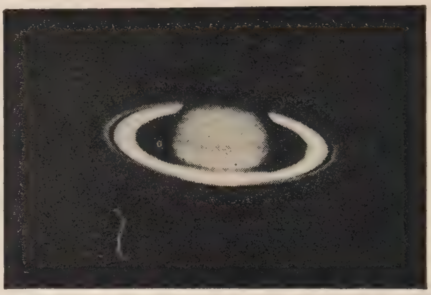
The invention of the telescope by Lippershey in 1608, used by Galileo two years later, was the turning point



*Galileo discovered four moons revolving around Jupiter.*



*Mars, the Mysterious.—Yerkes Observatory.*



*Saturn, and his rings,—the most spectacular object in the heavens.—Yerkes Observatory.*

in the study of heavenly bodies. Never before could details be seen, not even the mountains on the moon or Jupiter's satellites, but now a new field invited exploration and man has developed instruments of ever-increasing size and magnifying power to carry his studies further, and to find still more celestial bodies.

The investigation of the behaviour of a brilliant comet in 1682 by Halley led to the realization that some comets are part of our solar system and return periodically. The reappearances of many of these have been predicted, and are anticipated with considerable interest instead of the fear and wonder of earlier days.

The visual discovery of Uranus in 1781, the first planet to be found by means of a telescope, was followed by the mathematical proof that two more planets exist beyond it, and these, Neptune and Pluto, have since been definitely located.

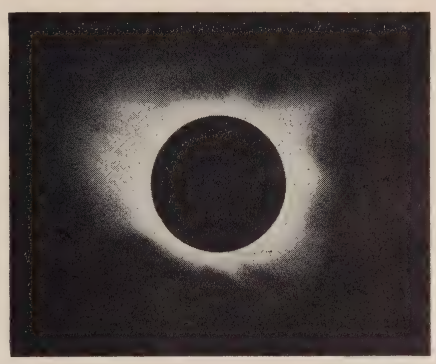
The unique and mysterious features of Mars, its surface, its movement and its moons, and also the possibility that it is inhabited, make it the most interesting planet to observe, while Saturn, with its system of rings, is the most spectacular.

The amateur who has a telescope at hand will realize the great advantage of seeing things for himself; his observations give him knowledge which is strictly his own,—beyond doubt or argument,—and he has the satisfaction of realizing the significance of what he sees through further study of the data to be found in many good text books.

There are now available, to professional and amateur alike, two valuable services which enable him to locate moving celestial objects for observation,—the Ephemeris and the Announcements of the Harvard College Observatory.

The Ephemeris, or Nautical Almanac, published annually, gives in advance the positions of sun, moon and all planets, also several of the satellites and asteroids, for every day of the year. The position is stated by "right ascension" in hours, minutes and seconds, and by "declination" in degrees north or south of the celes-

*Some comets have long streaming tails.—Yerkes Observatory.*



*A total eclipse of the Sun—a beautiful and awe-inspiring spectacle.—Mt. Wilson Observatory.*

tial equator,—corresponding, respectively, to the use of longitude and latitude for locating points on the earth. An object is found either by applying the information directly to graduated circles on the telescope mount, or by checking the position on a reliable chart in relation to certain readily visible stars and then using them as markers.

Harvard College Observatory is, as it were, the clearing house for all of the latest astronomical information and most recent discoveries in the heavens by observers all over the world. Anyone subscribing to this service receives promptly through the mail the "Announcement Cards" of this Observatory, giving description, brightness, position and direction of travel of new objects as they are found. These cards usually are mailed within two days of any discovery, followed later by others upon completion of calculations of the orbit. For many of the objects, the cards contain tabulated information giving positions each day for a month, and thus the observer frequently has opportunity to study the objects for a considerable time before they become visible to the unaided eye, and are announced in the newspapers.

In the series of articles, which now is being concluded, many of the outstanding facts and other interesting features have been mentioned. Amongst these there are,—

(a) The refusal of Galileo to believe what he had merely been told, and which was popular opinion, until he had proven it by experiment, and the valuable observations he made in consequence.

(b) The curiosity in Newton to learn why bodies fall to earth and his explanation of the force of gravity controlling motion throughout the Universe.

*The tidal bore, on the Petitcodiac river at Moncton, N.B.—a very impressive sight.*

(c) The stability of the planets and satellites travelling in elliptical orbits.

(d) The strange phenomenon demonstrated by comets that light repels rarefied matter.

(e) The astounding accuracy with which man can predict the occurrence of eclipses of sun or moon.

(f) The remarkable rings of Saturn which, as observed, cannot be solid, liquid or gas.

(g) Days, Years and Tides on our Earth.

(h) Information gleaned from the light of the stars.

While the heavens unfold many interesting features for observation, they also present many problems, and man throughout the years has been seeking the solutions of these. In some instances, by his diligence, he has met with success while in others he, up to the present, has been baffled completely. Surmounting all of these, however, is that riddle which both ancient and modern observers have tried to answer, that challenge today to man's mathematical genius and to

*The Twin Spiral Nebulae,—Twin Galaxies,—in the Constellation, Virgo.—Mt. Wilson Observatory.*

*Nebulae and visionary impressions by reflected starlight from Cygnus.
— French Astronomical Society, cut courtesy of Dr. C. A. Chant.*

his ability to build and apply still larger and better instruments, the eternal and inevitable question,—Why should these things be?—What is the purpose of all this grand display,—this Universe of ours? What is it all about?

Studying the heavens must surely lead us to realize that,—

"We are but part of one stupendous whole,
Whose body nature is, and God the soul." —*Pope.*

FINIS

* * * *

The following astronomical articles have been published in *The Bulletin*,—


*Advertising board operated by The Windsor Public Utilities Commission. The board is erected on a vacant lot on the main thoroughfare, and has at each end a display room similar to a shop window where various household electrical appliances are shown.*

# Resuscitation Medals Presented

ON April 14th, 1938, C. L. Burchiel, a lineman in the Line Maintenance gang, Western area, Niagara system — Operating Department, while working on a high tension pole at Seaforth Junction, received a severe electrical shock, which rendered him unconscious and stopped his breathing. The other members of the gang under Foreman F. Bailey, carried out artificial respiration and were successful in restoring his breathing. Mr. Burchiel was removed to hospital at Stratford, but due to the severity of his burns he died the next day.

The Canadian Electrical Association awarded the Canadian Electrical Association Resuscitation Medal to the gang, with replicas to each man. The presentation of the medal was made at New Hamburg on Wednesday, November 2nd, 1938, in the presence of G. L. Rous, George Terry and C. W. Moat. Wills Maclachlan presented the medal.

* * * *

On April 14th, 1938, William McLeod, an employee of Aylmer Rural Power District, while working on a rural line came in contact with the primary switch and received an electrical shock which rendered him unconscious and not breathing. E. C. Wisson and W. E. McConnell, employees of Aylmer Power District who were present, immediately started artificial respiration and restored his breathing. After a few days' absence, Mr. McLeod was able to return to his duties.

The Canadian Electrical Association awarded the Canadian Electrical Association Resuscitation Medal to Aylmer Rural Power District with replicas of the medal to Mr. Wisson and Mr. McConnell.

The presentation of the medal took place at a social evening arranged by employees of No. 3 Area, in the Community Hall at Dorchester on Monday evening, November 28th, 1938. A. H. Farrell, Superintendent, received the medal and Mr. Wisson and Mr. McConnell each received a replica. There were present a considerable number of employees from the district, with their wives and also present Hugh Duncan, Niagara Falls, H. C. McElrath, Belleville, and W. A. McKenzie, Adam Smith, I. K. Sitzer and John MacLellan of Toronto. Wills Maclachlan made the presentation.

# The Late Dr. René Thury

THE death of Dr. René Thury, occurred recently in Geneva at the age of 78. Dr. Thury was well known to electrical engineers as the protagonist of a system of power transmission by high tension direct-current and as the inventor of a voltage regulator, which is still widely used.

René Thury was born in Geneva, and after attending local schools entered the service of the Société Genevoise pour la Construction d'Instruments de Physique as a pupil at the age of fourteen. Here he attracted the attention of Emil Burgin, who was afterwards well-known for his work on the dynamo, and was employed by him on a variety of work connected with electrical measurements. In 1879 the first Edison incandescent lamps appeared in Geneva and in order that they could be used Thury successfully tackled the problem of designing a shunt-wound dynamo, which would take the place of the series-wound dynamo then employed for supplying arc lamps. He also succeeded in producing workable lamps when the first consignment from the United States had been exhausted. In the course of this work he established a personal connection with Edison whom he visited, and on his return to Geneva in 1881 became technical director of a firm which he established with A. de Meuron and H. Cuénod. Three years later he succeeded in designing a six-pole dynamo, which gained him a gold medal at the Turin exhibition of that year. At the beginning of the nineties he turned his attention to the problem of railway electrification, and was one of the first to suggest the use of a third rail for the collection of the traction current. The first power transmission scheme in Switzerland, with a capacity of 40 h.p. at 500 volts, was also erected by him from Taubenlochschluct to Bözingen.

It was in 1889 that he first devised the system of high voltage direct-current power transmission which will always be associated with his name. This consisted essentially of arranging a number of generators in series at the transmitting end and supplying a number of motors also connected in series in one or more substations at the receiving end of the line. The current transmitted was kept constant, alterations in the power demand being met by inserting or short-circuiting one or more machines, so as to increase or diminish the voltage. The system was used in practice to transmit 4,000 k.w. at a maximum of 27,000 volts from St. Maurice to Lausanne, a distance of 69.6 miles, and for conveying about the same power from Moutiers to Lyons, a distance of 111.8 miles at a maximum pressure of 57,600 volts. It is interesting to note that a part of the transmission system on the latter scheme was underground. At the suggestion of J. S. Highfield the Thury principle was used in England to supply an area of 300 square miles in the neighbourhood of London, and its advantages were fully dealt with

by him in a paper read in 1907 before the Institution of Electrical Engineers. Nearly every speaker in this discussion, including Lord Kelvin, emphasised its advantages. Nevertheless the application it has received is small and the same is true of other similar systems even where large blocks of power can be transmitted between two terminal points, with no intermediate tappings. This lack of recognition is probably to be explained by the undoubted complications of the necessary switching equipment.

Thury's other claim to fame—his voltage regulator—possesses the great advantage of having very light moving parts. It was originally developed in connection with the direct-current transmission system, and consisted essentially of a rheostat in the field circuit, the arm of which was driven by a tooth wheel. At the edge of this wheel was a rocker which was continuously moved backwards and forwards by pawls, the latter being brought into action by a lever which was actuated by two solenoids connected in the exciter system. This regulator, which is of great sensitivity, was constructed by the Compagnie de l'Industrie Electrique, established by its inventor, and the same firm also manufactured the high-frequency generator which was much used in the early days of radio communication. Later, Thury was connected with the Société Alsacienne de Constructions Mécaniques Belfort.

Thury was an Officer of the Legion d'Honneur, and was the recipient of honorary degrees from more than one University. He was elected an Honorary Member of the Institution of Electrical Engineers in 1934.

—*Engineering.*

# Convention Programmes

THE Annual Meeting of the Ontario Municipal Electric Association and the Winter Convention of the Association of Municipal Electrical Utilities will be held concurrently at the Royal York Hotel, Toronto, on February 7th and 8th, 1939. The programmes of the two associations have been so arranged that there will be two joint sessions, namely on the afternoon of each day. On each morning each association will hold a separate session of its own. They will also follow the usual practice of meeting together for the convention luncheons and dinner.

* * * *

## Accident Prevention Meeting

On the evening of Monday, February 6th, there will be a dinner meeting beginning at 6.00 o'clock. This meeting has been arranged under the joint auspices of the Committee on Accident Prevention and Health Promotion of the Association of Municipal Electrical Utilities and the Electrical Employers Association of Ontario. The managers of the utilities will discuss the various accidents that have occurred during the past year and as a round table conference will discuss generally suggestions for the prevention of accidents in the future. The application of the Workmen's Compensation Act to an electrical utility in Ontario will also be discussed.

* * * *

## O. M. E. A.

The programme of the Annual Meeting of the Ontario Municipal Electric Association has been tentatively arranged as follows:

Monday—February 6th.

*Evening.*

8.00 o'clock—Executive Meeting.

Tuesday—February 7th.

*Morning.*

Registration.

10.00 o'clock—General Meeting.

Minutes.

President's Address.

Secretary's and Executive's Report.

Treasurer's Report.

Resolutions.

*Afternoon.*

12.30 o'clock—Convention Luncheon with A.M.E.U.

Address by Dr. T. H. Hogg, Chairman, The Hydro-Electric Power Commission of Ontario, Toronto.

2.30 o'clock—Convention Session with A.M.E.U.

"Review of Hydro Operations for 1938 and Forecast for 1939" by speakers to be furnished by The Hydro-Electric Power Commission of Ontario, Toronto.

*Evening.*

6.30 o'clock—Convention Dinner with A.M.E.U.

Address.

Entertainment.

Wednesday—February 8th.

*Morning.*

9.30 o'clock—General Meeting.

Reports of Committees—Credentials Committee.

District Directors.
Election of Officers.
Reports of Committees—
Resolutions Committee.
Finance Committee.
Water Heater Committee.
Insurance Committee.
Report of Convention Committee.
Unfinished Business.
New Business.
General Discussion.
*Afternoon.*
12.30 o'clock—Convention Luncheon with A.M.E.U. and the Electric Club of Toronto.
Address—"Construction Features of the New York World's Fair 1939", by C. W. Nickerson, Electrical Engineer, New York World's Fair 1939.
2.30 o'clock—Convention Session with A.M.E.U.
Presentation of "Sales Promotion" Program of the H.E.P.C. of Ontario by M. J. McHenry, Director, Sales Promotion of The Hydro-Electric Power Commission of Ontario and members of the Sales Promotion Department, assisted by the staff of the McLaren Advertising Company, Toronto, followed by demonstrations on Commercial Cooking and Commercial Lighting.

* * * *

## A. M. E. U.

The foregoing tentative programme of the O.M.E.A. Annual Meeting outlines certain sessions as well as the convention luncheons and dinner to be held jointly with the A.M.E.U. In the following outline of the programme of the Winter Convention of the Association of Municipal Electrical Utilities, for the sake of brevity the reader is referred back to the O.M.E.A. programme, and only the separate sessions listed.

Tuesday—February 7th.
*Morning.*
Registration.
10.30 o'clock—Convention Session.
Reports of Committees.
*Afternoon.*
12.30 o'clock—Convention Luncheon with O.M.E.A.
(See O.M.E.A. programme.)
2.30 o'clock—Convention Session with O.M.E.A.
(See O.M.E.A. programme.)
*Evening.*
6.30 o'clock—Convention Dinner with O.M.E.A.
(See O.M.E.A. programme.)
9.00 o'clock—Executive Committee Meeting.

Wednesday—February 8th.
*Morning.*
9.30 o'clock—Convention Session.
Paper—"Unit Sub-Stations" by E. E. Forest, Gary Heat, Light and Water Company, Gary, Indiana.
Paper—"Wire Mileage Data Record" by W. R. Catton, Manager Hydro Department, Public Utilities Commission, Brantford.
Paper—"Selling Commercial Lighting" by B. W. Grover, The Public Utilities Commission, London.
*Afternoon.*
12.30 o'clock—Convention Luncheon with O.M.E.A. and the Electric Club of Toronto.
(See O.M.E.A. programme.)
2.30 o'clock—Convention Session with O.M.E.A.
(See O.M.E.A. programme.)

* * * *

# A. M. E. U. Election Ballot

The election of officers of the Association of Municipal Electrical Utilities will take place on Tuesday, February 7th. Delegates will receive their ballots on the morning of that day and up to the opening of the afternoon session. Immediately after the opening of this session the ballot will be closed and the results of the elections announced before that session adjourns. The ballots will show the following as candidates:—

PRESIDENT—G. E. Chase, Bowmanville. (Acclamation.)

VICE-PRESIDENT—W. G. Henderson, Cobourg and A. B. Manson, Stratford.

SECRETARY—S. R. A. Clement, H.E.P.C. of Ontario, Toronto. (Acclamation.)

TREASURER—F. A. Archer, H.E.P.C. of Ontario, Toronto and S. E. Preston, H.E.P.C. of Ontario, Toronto.

DIRECTORS (*from the membership at large*)—W. R. Catton, Brantford; V. A. McKillop, London; J. W. Peart, St. Thomas; C. E. Schwenger, Toronto; C. A. Walters, Napanee; and P. B. Yates, St. Catharines.

DISTRICT DIRECTORS—

NIAGARA DISTRICT—J. G. Hare, East York Twp. and H. R. Hatcher, Galt.

CENTRAL DISTRICT—O. H. Scott, Belleville. (Acclamation.)

GEORGIAN BAY DISTRICT—C. E. Brown, Meaford and R. S. King, Midland.

EASTERN DISTRICT—S. W. Canniff, Ottawa; A. L. Farquharson, Brockville and R. J. Smith, Perth.

NORTHERN DISTRICT—R. B. Chandler, Port Arthur. (Acclamation.)

* * * *

# O. H. E. Club Dance

The annual dance of the Ontario Hydro-Electric Club will be held at the Royal York Hotel on the evening of Wednesday, February 8th. The Club extends a hearty invitation to all O.M.E.A. and A.M.E.U. delegates and their friends to attend.

## Cooking School at Mitchell

A very successful cooking school was held in the Town Hall at Mitchell on November 2nd and 3rd. This was sponsored by the Mitchell Public Utilities Commission and conducted by the Canadian General Electric Company's experts. The three sessions of the school were all well attended, a total of 675 interested ladies having witnessed the demonstrations. It is reported that many prospects were obtained for new electric ranges as a result of this effort.

# Index to Volume XXV

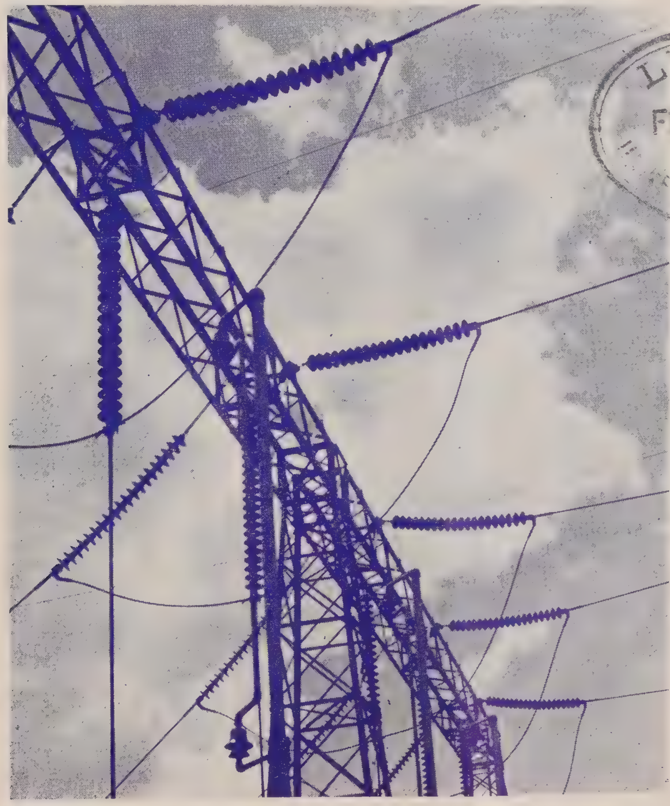
*Alexander development, Nipigon river.*

# The BULLETIN


Hydro-Electric Power Commission of Ontario

Volume XXVI JANUARY, 1939 Number 1





*Toronto-Leaside T.S., 220 kv. entrance structure.*

# Municipal Loads, December, 1938

NIAGARA SYSTEM
25 Cycle

| Municipality | H.P. | Population |
|---|---|---|
| Acton | 975 | 1,993 |
| Agincourt | 176 | P.V. |
| Ailsa Craig | 126 | 452 |
| Alvinston | 98 | 643 |
| Amherstburg | 865 | 2,879 |
| Ancaster Twp. | 396 | V.A. |
| Arkona | 62 | 415 |
| Aurora | 1,200 | 2,758 |
| Aylmer | 713 | 1,995 |
| Ayr | 201 | 770 |
| Baden | 320 | P.V. |
| Beachville | 423 | P.V. |
| Beamsville | 461 | 1,208 |
| Belle River | 176 | 748 |
| Blenheim | 541 | 1,755 |
| Blyth | 119 | 624 |
| Bolton | 174 | 569 |
| Bothwell | 137 | 642 |
| Brampton | 2,690 | 5,568 |
| Brantford | 15,891 | 31,232 |
| Brantford Twp. | 791 | V.A. |
| Bridgeport | 128 | P.V. |
| Brigden | 88 | P.V. |
| Bronte | 170 | P.V. |
| Brussels | 139 | 787 |
| Burford | 170 | P.V. |
| Burgessville | 48 | P.V. |
| Caledonia | 359 | 1,370 |
| Campbellville | 35 | P.V. |
| Cayuga | 140 | 674 |
| Chatham | 6,555 | 15,910 |
| Chippawa | 321 | 1,187 |
| Clifford | 86 | 441 |
| Clinton | 545 | 1,865 |
| Comber | 165 | P.V. |
| Cottam | 84 | P.V. |
| Courtright | 47 | 286 |
| Dashwood | 80 | P.V. |
| Delaware | 60 | P.V. |
| Delhi | 661 | 1,701 |
| Dorchester | 128 | P.V. |
| Drayton | 115 | 566 |
| Dresden | 397 | 1,468 |
| Drumbo | 88 | P.V. |
| Dublin | 43 | P.V. |
| Dundas | 1,779 | 4,757 |
| Dunnville | 1,193 | 4,001 |
| Dutton | 272 | 776 |
| Elmira | 676 | 2,063 |
| Elora | 340 | 1,138 |
| Embro | 93 | 449 |
| Erieau | 67 | 238 |
| Erie Beach | 12 | 26 |
| Essex | 469 | 1,798 |
| Etobicoke Twp. | 6,562 | V.A. |
| Exeter | 471 | 1,629 |
| Fergus | 999 | 2,785 |
| Fonthill | 125 | 803 |
| Forest | 451 | 1,586 |
| Forest Hill | 7,995 | 9,147 |
| Galt | 7,680 | 14,119 |
| Georgetown | 1,329 | 2,189 |
| Glencoe | 205 | 778 |
| Goderich | 1,239 | 4,336 |
| Granton | 59 | P.V. |
| Guelph | 9,828 | 21,455 |
| Hagersville | 436 | 1,345 |
| Hamilton | 104,001 | 154,020 |
| Harriston | 358 | 1,273 |
| Harrow | 395 | 918 |
| Hensall | 174 | 719 |
| Hespeler | 2,044 | 2,861 |
| Highgate | 83 | 327 |
| Humberstone | 480 | 2,563 |
| Ingersoll | 2,410 | 5,139 |
| Jarvis | 206 | 504 |
| Kingsville | 684 | 2,282 |
| Kitchener | 2,091 | 32,650 |
| Lambeth | 139 | P.V. |
| LaSalle | 240 | 782 |
| Leamington | 1,572 | 5,340 |
| Listowel | 1,045 | 2,819 |
| London | 38,518 | 73,091 |
| London Twp. | 596 | V.A. |
| Long Branch | 1,027 | 4,099 |
| Lucan | 198 | 613 |
| Lynden | 94 | P.V. |
| Markham | 348 | 1,112 |
| Merlin | 84 | P.V. |
| Merritton | 5,819 | 2,543 |
| Milton | 1,014 | 1,785 |
| Milverton | 324 | 987 |
| Mimico | 2,767 | 6,876 |
| Mitchell | 540 | 1,577 |
| Moorefield | 36 | P.V. |
| Mount Brydges | 108 | P.V. |
| Newbury | 39 | 276 |
| New Hamburg | 564 | 1,464 |
| Newmarket | 1,550 | 3,526 |
| New Toronto | 7,149 | 6,848 |
| Niagara Falls | 9,992 | 18,747 |
| Niagara-on-the-Lake | 464 | 1,563 |
| Norwich | 407 | 1,174 |
| Oakville | 1,094 | 3,868 |
| Oil Springs | 219 | 472 |
| Otterville | 111 | P.V. |
| Palmerston | 488 | 1,410 |
| Paris | 1,321 | 4,315 |
| Parkhill | 166 | 997 |
| Petrolia | 1,119 | 2,720 |
| Plattsville | 78 | P.V. |
| Point Edward | 1,303 | 1,252 |
| Port Colborne | 2,177 | 6,196 |
| Port Credit | 848 | 1,755 |
| Port Dalhousie | 716 | 1,459 |
| Port Dover | 376 | 1,665 |
| Port Rowan | 87 | 666 |
| Port Stanley | 262 | 741 |
| Preston | 2,970 | 6,294 |
| Princeton | 103 | P.V. |
| Queenston | 122 | P.V. |
| Richmond Hill | 445 | 1,268 |
| Ridgetown | 603 | 1,983 |
| Riverside | 1,117 | 5,017 |
| Rockwood | 123 | P.V. |
| Rodney | 185 | 724 |
| St. Catharines | 14,674 | 26,834 |
| St. Clair Beach | 63 | 100 |
| St. George | 143 | P.V. |
| St. Jacobs | 256 | P.V. |
| St. Marys | 1,348 | 4,023 |
| St. Thomas | 7,800 | 16,088 |
| Sarnia | 8,689 | 18,230 |
| Scarborough Twp. | 4,047 | V.A. |
| Seaforth | 552 | 1,717 |
| Simcoe | 2,198 | 5,614 |
| Smithville | 276 | P.V. |
| Springfield | 67 | 365 |
| Stamford Twp. | 2,459 | 7,842 |
| Stouffville | 242 | 1,155 |
| Stratford | 6,785 | 17,555 |
| Strathroy | 1,216 | 2,911 |
| Streetsville | 163 | 636 |
| Sutton | 177 | 831 |
| Swansea | 2,991 | 5,504 |
| Tavistock | 554 | 1,034 |
| Tecumseh | 320 | 2,432 |
| Thamesford | 198 | P.V. |
| Thamesville | 249 | 788 |
| Thedford | 95 | 585 |
| Thorndale | 52 | P.V. |
| Thorold | 2,161 | 4,959 |
| Tilbury | 710 | 1,992 |
| Tillsonburg | 1,441 | 3,702 |
| Toronto | 362,158 | 645,462 |
| Toronto Twp. | 2,490 | V.A. |
| Trafalgar Twp. | 613 | V.A. |

# THE BULLETIN

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# Testing and Research in an Electrical Utility

By W. P. Dobson, Chief Testing Engineer, H.E.P.C. of Ontario

THE last twenty years have seen the origin and development of a new epoch in America in the application of science to industry. Research has become a term of popular use and the public has now some faint idea of what it means. In contrast to this situation, the term research was scarcely understood by the public at large twenty-five years ago, and few industrial concerns had research laboratories. In fact, the potential benefits of industrial research were not generally appreciated in industry. Most of the research work carried on was in the field of pure science and was promoted by the universities. Now research laboratories are important features of all large industrial concerns. Many of these also carry on research in pure science. This combination of pure and industrial research has produced astounding results in many cases which have operated to the profit of the companies promoting it.

We are interested here in the place of electric utilities in research, and for the purpose of this discussion it will be useful to focus attention on the principal aims of industrial research. These may be stated thus: (1) the development of new materials and combinations of materials; (2) the development of methods of using materials and equipment.

The manufacturer is interested in both of these aims, particularly in the first. The electric utilities on the other hand are vitally interested in the behaviour of the products supplied by manufacturers, under the conditions existing on power systems. They are thus involved in the study of natural phenomena and of condi-

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Paper presented to the Engineering Institute of Canada at Hamilton on December 13, 1938.

## CONTENTS

Vol. XXVI No. 1
January, 1939



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

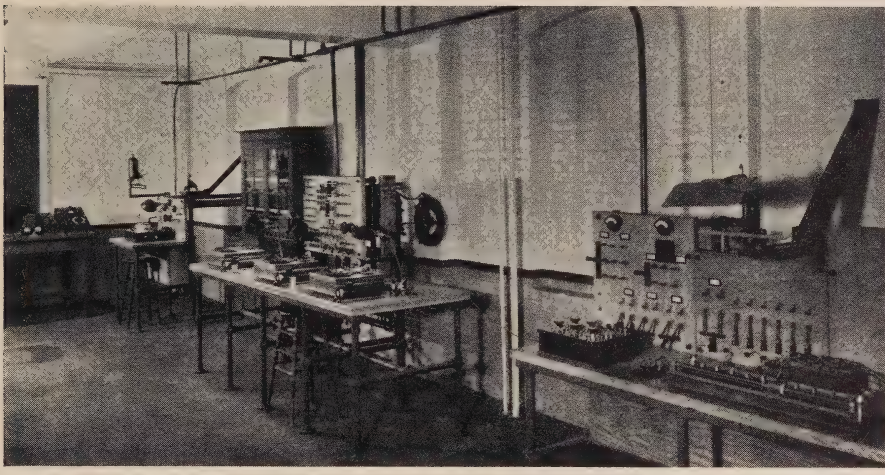
tions on electric circuits which may be destructive to equipment. It is not possible to delegate this study to the manufacturer or to other outside agencies for it demands in any utility the continuous attention of a staff thoroughly familiar with the organization. While, in one sense, a power system is a laboratory in which manufacturers must test their developments, the testing is peculiarly the duty of the power company.

This defines the place of the electric utility in research which thus embraces a broad field in engineering theory and practice, and in the properties of materials, and requires for its proper pursuit, a well-equipped laboratory and a staff which must be permitted to devote its energies to more specialized and scientific studies than those engineers engaged wholly in problems of design, construction and operation.

Testing is an important function of a utility. Its purpose is (1) to determine the quality of material and equipment submitted for purchase and its compliance with guarantees, and (2) to control and maintain the quality of material and equipment in service by periodic tests and examinations which will detect signs of failure.

The extent and scope of the testing and research work carried on by an electric utility will depend upon the size of the company but is also an important matter of policy. The investment in equipment and personnel must be large if the work is to be efficiently executed. On the other hand, the necessity for protecting its investment will force the organization to make important purchases under strict specifications, and to take every practicable means of maintaining the quality and lengthening the life of its equipment. Whether the testing and inspection shall be done by the organization or be delegated to outside organizations is a question which is subject to varied treatment in different utilities. It is a fact, however, that practically all the large electric utilities in America have departments, which carry on testing and research and have important executive functions connected therewith.

The Hydro-Electric Power Commission of Ontario maintains a Testing and Research Department and a laboratory equipped for electrical, chemical, photometric and mechanical



*The Standards Room, in which electrical instruments are calibrated, and measurements of very high accuracy are made.*

testing. The staff numbers 90 engineers, physicists, chemists and laboratory assistants.

The first function of the department is to supply a testing and inspection service to the Commission and its municipalities not only in connection with the purchasing of materials and equipment but also in the maintenance and operation of the systems. The latter requirements are responsible for a large and increas-

*The Wire Testing Laboratory, where different types of insulation on wires and flexible cords are inspected and tested.*

ing volume of testing, while the work connected with purchasing fluctuates depending upon constructional activities.

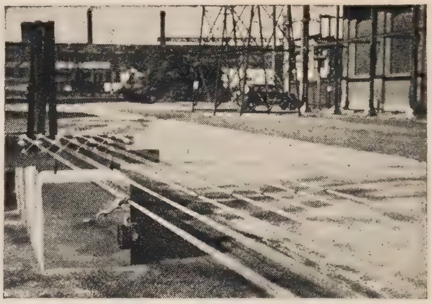
The department is also responsible for the conducting of special investigations and research. The problems presented are usually of a practicable nature, and no attempt is made to undertake research in pure science.

A. Testing and Inspection

*General*

The department inspects and tests all classes of material and equipment purchased by the Commission, to determine compliance with the specifications. This inspection covers, foundry work on iron and steel castings; forgings, machining and assembly of turbines, generators and powerhouse equipment; welding of all kinds; shop fabrication of structural steel for buildings, transmission towers, etc.; plate work, such as is required in the manufacture of penstocks, draft tubes, pressure and transformer tanks; rolling of reinforcing steel; drawing of wire and stranding of copper, galvanized steel, and steel-reinforced aluminum cables; transmission line materials, such as bolts, clamps, cross arms, etc., and electrical tests on all types of equipment. The requirements of these items are included in general material specifications, or in specifications for individual jobs in the preparation of which the department assists.

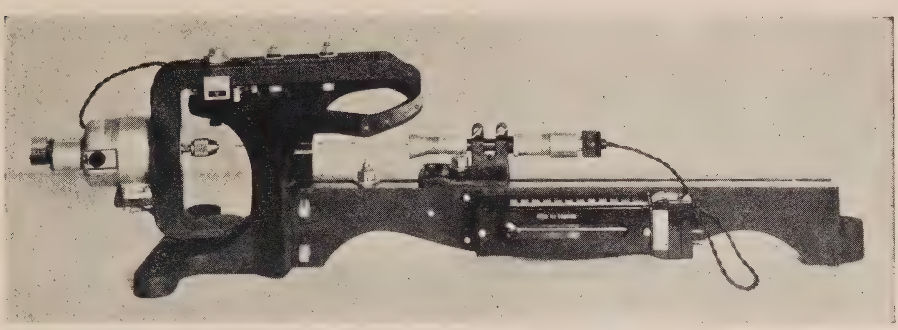
A considerable amount of testing is involved in this work, some of which is done at the manufacturers' plants, and some at the Laboratories. Physical tests are supplemented by chemical analyses and often by microscopic examination to determine the suitability of the materials for the purpose intended. Electrical tests are usually made in the factory, but on very large units they must be made in the field after the erection of the equipment.



*Power line conductors on the experimental span, under mechanical fatigue test showing the nodes and loops of the vibrations.*

The machining of all parts for turbines and generators is carefully observed, and the fit and finish are checked during the operation of machining and also while the units are being assembled. Welding operations are given careful attention.

The acceptance tests on a large turbine and generator unit are made in the field after erection has been completed. Such a test requires a staff of engineers and assistants and sometimes consumes several weeks. It involves the determination of temperature rise under load, turbine and generator efficiency, the application of specified dielectric tests to the insulation, the observation of performance under conditions of overspeed and sudden short-circuit, and forms the basis of acceptance or rejection of the unit.



*Fatigue Testing Machine, for steel wire, in which specimens are rotated at high speed and with known stresses to obtain the endurance limits of conductors under continued vibration.*

The benefits to be derived from inspection will depend on the policy adopted and on the efficiency of the inspection. It must be comprehensive, and at the same time due regard must be given to the economic factor. A haphazard policy in determining what shall be inspected will defeat the aim desired, but on the other hand judgment must be continually exercised in determining the extent and necessary detail of the work. The inspection staff should also have an intimate knowledge of the organization. If these desiderata are fulfilled several important advantages will result.

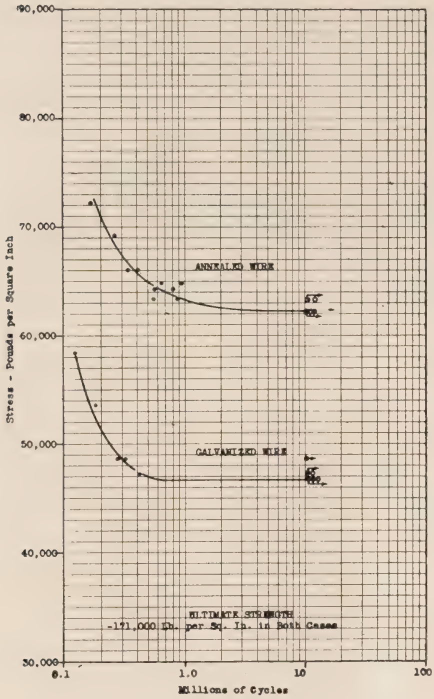
The reliability of equipment will be improved, and this should indirectly reduce the possibility of failures in operation; the elimination of defective materials and poor workmanship will expedite field work by avoiding or reducing delays in erection programs; information is obtained regarding the capacity of shops to perform special classes of work; information on the properties of materials and methods of shop operation, forms the basis of improvements in specifications; the inspector by following the work through the shop assists in obtaining compliance with delivery guarantees.

*Miscellaneous Electrical Testing*

The investigation of troubles arising in operation, the determination of the merits of new materials and equipment, and studies leading to improvements in methods and materials are responsible for a large amount of testing. Many of these problems become the subject of systematic and extended study under the research program described below. The failure of equipment, and the deterioration of materials are the principal sources of these problems.

The periodic testing and inspection of materials in service is an important function of the department. This gives information which dictates the necessity for special treatment or replacement. Important examples are oil, rubber gloves, metals and concrete.

Insulating oils used in transformers and circuit breakers are tested periodically. Dielectric tests are made




*Comparative Fatigue Characteristics of steel wire with, and without galvanizing,—data obtained from the fatigue testing machine.*

monthly on samples from the higher voltage equipment and less frequently in the case of other equipment. Supplementing these tests an extensive survey of the conditions of all insulating oils is made at intervals of two or three years. Tests are made for acidity, sludge-forming properties and resistance to emulsification and form the basis of recommendations for treatment.

Lubricating oils also receive attention and records are available of the change in properties of generator oils in the most important plants extending over the life of the plants. They are relied upon entirely by the Operating Department as a guide in treating or replacing the oil.

Linemen's gloves are purchased under A.S.T.M. specifications, and are subject to a strict inspection routine thereafter, under the general supervision of the Accident Prevention Department. The stock is kept in the Laboratory, and gloves are issued to the field in special containers bearing Laboratory seals indicating the date of tests and shipment. The field foreman is responsible for the gloves in the field and must return them periodically to the Laboratory where they are subjected to dielectric test and visual examination.

*Concrete*

The investment of the Commission in concrete structures is very great, and it is therefore natural that it should have given early attention to the problems involved in the manufacture and maintenance of this material.

In 1918, the Laboratory began, at the request of the Engineering Department, to develop methods of controlling concrete in order to maintain predetermined quality, and thus inaugurated a systematic and continuous study which has been most successful in securing good quality and permanence.

The Hydro-Electric Power Commission was the first large organization to adopt strength specifications for concrete, i.e., to specify quality by compressive strength rather than by arbitrary proportions. This method is in almost universal use today. The control of quality by using the relation of strength to "water-cement

ratio" was first practised on large jobs by the Commission. The effect of field methods on quality has been given intensive study from the first, and this organization was one of the first to apply close control of aggregates, exact methods of measurement and mixing, and care in placing. The Commission was the first Canadian organization and one of the first in America to adopt the method of proportioning aggregates on large jobs by weight.

Methods of designing mixes have been developed which are simple, exact and inexpensive. The tests necessary to permit the accurate design of concrete mixes for a job costing $100,000 may be made for $100.00, while $500.00 is sufficient to cover the Laboratory investigation of mixes on a $1,000,000 job.

The procedure in inspecting and controlling the quality of concrete on any job is as follows:

The first step must be taken long before construction begins and consists in a survey by the Laboratory of available sources of fine and coarse aggregate. When a suitable deposit has been found, laboratory tests are made on the materials and preliminary designs for concrete mixes are decided upon. Assistance is given the Construction Department in designing the concrete plant.

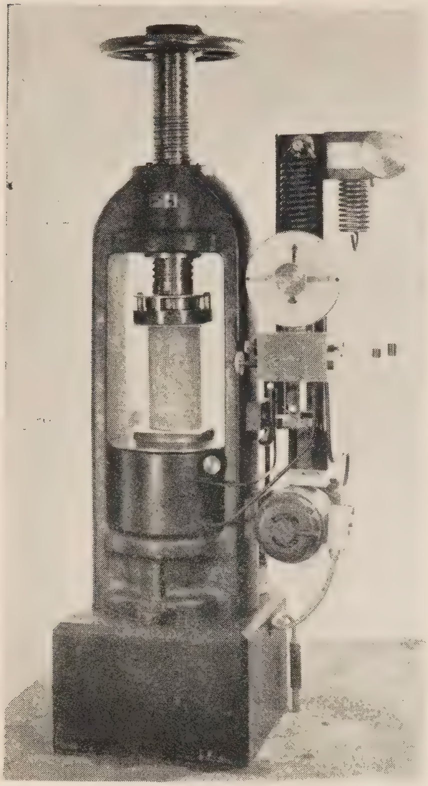
When construction work begins, inspectors from the Laboratory working under the direction of the Resident Engineer, inspect each detail of proportioning, mixing and placing of the concrete. They make tests on the aggregate delivered, and may from time to time alter the proportions of the mix in order to maintain the required strength. On large jobs and on jobs remote from the Laboratory, field laboratories are equipped with their use. The protection of the concrete after placing, against the effects of low or high temperatures is given close attention. A complete record of the concrete is maintained during the period of construction, and its condition when placed in service is carefully noted and reported.

A system of periodic field inspection of all the Commission's concrete structures is followed by the Laboratory. Every important structure and many of the minor ones are thoroughly inspected at least every three years, and a complete record including a photographic survey, is made. The rate of deterioration can thus be determined and the need of repairs recognized. In many cases remedial measures can be taken which forestall the necessity of major repairs.

### B. RESEARCH

Problems of research are suggested by difficulties which arise in design, construction and operation. These indicate a need for improvements in materials or equipment, for a knowledge of conditions detrimental to service, and methods of combatting these conditions; for information about the characteristics of available materials and their suitability for use on the system; and for the development of methods and equipment for special applications.

The work is organized so as to obtain the co-operation of all departments and the assistance of all members of the staff who can be of value.



*New Hydraulic Compression Testing Machine, for concrete, stone, wood and other materials. Capacity—400,000 lbs.*

*The Research Committee*

A Research Committee composed of the heads of the Hydraulic, Electrical, Operating, Municipal and Research Departments gives general direction to the work, which is carried on by subcommittees appointed for particular projects, and including representatives from all departments interested. Fourteen subcommittees are now active containing a total membership of 63. In addition, members are co-opted for specific tasks.

The bulk of the experimental work is done by the Laboratory staff who report their findings to the various subcommittees. Recommendations based upon the work are forwarded to the Main Research Committee and if approved, are issued as instructions by the appropriate executive officers.

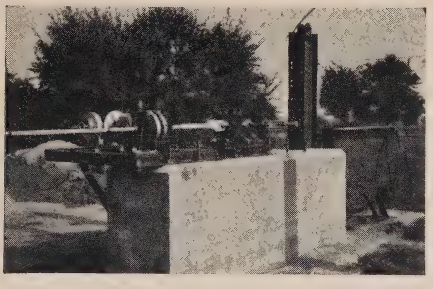
The examples given below have been chosen with the object of illustrating the method of operation, and of indicating some of the results obtained.

*Vibration of Line Conductors*

The problem first came to the attention of power companies about 1923 when longer spans and higher mechanical tensions gained favour among designers in their endeavour to make the most economical use of materials. The trouble was revealed by breakages at clamps and investigation showed that these were due to line vibrations which set up stresses in excess of the fatigue limits of the conductor material.

The seriousness of the situation may be grasped from the fact that in some instances as many as 30 individual breaks were found at one point in a conductor. Constant inspection was necessary to avoid interruptions due to fallen conductors. It was important to find a satisfactory solution to the problem not only from the point of view of protecting existing lines but also as a means whereby those designs of line known to be most economical could safely be used.

The problem was attacked from two different directions, viz., the investigation of remedial measures for reducing the vibrations to harmless proportions and on the other hand



*The Vibration Generator in the Laboratory yard, used in fatigue tests on power line conductors to produce artificial vibrations on an experimental span.*

the endeavour, through fatigue tests and metallurgical studies, to find materials more capable of withstanding vibration.

The search for satisfactory palliative measures has involved both theoretical and practical studies. To a large extent the practical studies have been conducted in the field where suitable test spans are available for observing the behaviour of various devices installed on lines strung for this purpose. In connection with this work, it was necessary to design special recording apparatus and to develop a method which would yield information of a quantitative nature as to the damping characteristics of cables and devices.

Through these tests, much has been learned as to the damping characteristics of the conductor at various tensions and as to the efficiency of various devices claimed to have merit in reducing line vibration. The observations made in the field have also initiated ideas on the part of the staff which have resulted in the development of a new damping arrangement which gives promise of being of considerable value. This has been patented and is called a "Torsional Damper".

Another important part of the program is the inspection of existing lines to establish those locations where vibration conditions are most severe, and the observation of lines which have been provided with dampers.

In the investigation of line materials, tests are being made to determine fatigue limits and the effect of manufacturing processes on the quality of the wire. Up to the present time the tests have been confined to steel wire but eventually other materials used in line construction will also be investigated. The efficacy of new materials and protective coatings is also being studied.

It has been found that manufacturing processes have a pronounced effect upon the ability of materials to withstand alternating bending stress and this has dictated the necessity for adopting conservative design stresses in cables subjected to vibration.

An important factor is the effect of low temperatures on the fatigue and impact values of cable materials. Serious breakages recently experienced in cables strung in Northern Ontario indicate that at sub-zero temperature the ability of materials to withstand bending and impact is reduced to a marked degree. This feature is now being investigated.

Associated with the fatigue of materials is the investigation of line clamps, ties and fittings to determine those types which place the most severe duty on the conductor. Tests

of this nature are being made at the Laboratory on a 150-foot experimental span. In these tests, vibrations are generated mechanically and the cable is tested to failure. At the present time comparative tests are being made on clamp connections proposed for live line work where load conditions will not permit power to be interrupted for a sufficient length of time to install the conventional tie connections.

During recent months endurance tests have been carried out on the laboratory span to investigate the possibility of mechanical injury due to cold flow of the conductor material at points where dampers are attached to vibrating cables, and to observe the effect of interstrand friction and torsional action on sections of cable immediately adjacent to certain types of damper installations. The experimental span has also been found useful in preliminary studies of damper spacings and disposition of materials.

*Insulation Problems*

Another subcommittee is studying problems of insulation. During the past year, it undertook the task of determining the best criterion of the condition of transformer and circuit breaker bushings. After a series of laboratory tests in which comparisons of several methods were made it was concluded that a method employing potential gradient was most satisfactory. An instrument developed by a member of the Laboratory staff is being used with satisfactory results. Laboratory tests on bushings removed from service have confirmed the results obtained with this instrument in the field. Some of the types of fault or weaknesses discovered may be of interest:

Loss of compound in small amounts does not appear to impair seriously the serviceability of a bushing, the presence of partial or complete short-circuit between layers in condenser bushings can be detected quite readily. Other faults tending to disturb the gradient include: large cavities in the compound, moisture due to imperfect sealing, and progressive burning of insulation in the interior caused by local static streamers. Parallel studies on these types of faults by power factor methods gave no results of significance.

This subcommittee is also classifying insulation problems of importance to the Commission, and is planning a systematic method of attack upon them.

*Concrete*

The method of inspecting concrete has been described earlier. In addition to this a permanent committee is engaged in investigations of various features of concrete practice. The field inspection of our own and foreign structures is yielding information on the deterioration of concrete. The study of methods of treating diseased concrete naturally follows and the committee has been actively engaged in this study for over ten years.

At the present time the subcommittee is giving considerable attention to the study of the disintegration of concrete and is trying to correlate the strength with chemical changes taking place due to water percolation or evaporation. It is hoped that this study may lead to the application of

preventive methods in advance of disintegration. Other subjects of investigation are the use of admixtures, the use of slag from mining operations for the construction of concrete dams; special materials submitted from time to time and claimed to be of value in concrete repair operations. The subcommittee is studying the classification of concrete and the revision of existing purchase specifications for concrete aggregates.

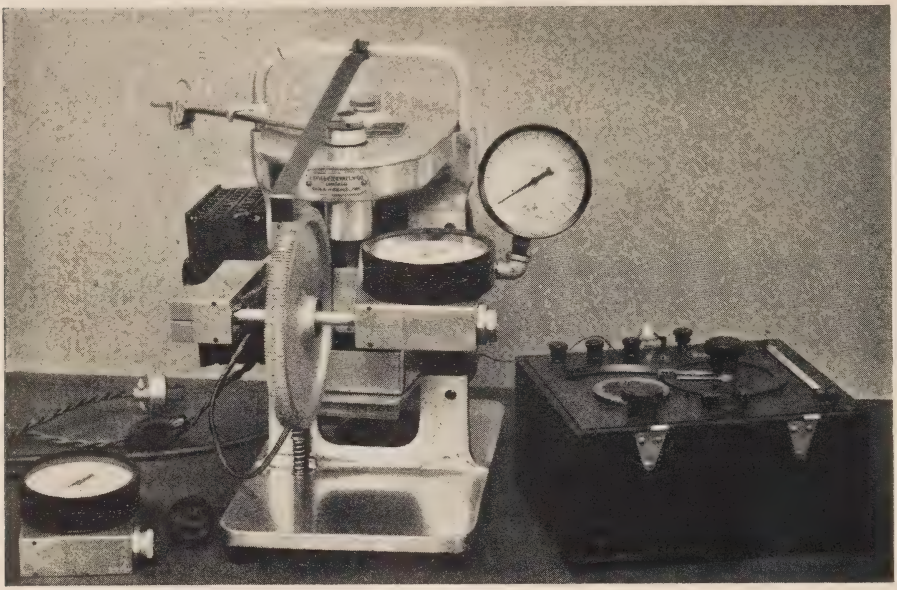
An important problem is the protection of concrete in cold weather. The importance of this will be realized when it is stated that on any major concrete structure erected in this climate, a considerable portion of the concrete will be poured during the cold weather. Jobs are commenced in the early spring, and concreting cannot begin until the necessary excavation has been completed, which is usually late in the summer, so that the bulk of the concrete must be poured during the fall, winter and spring to permit completion of the job the following summer. Concrete has been placed by the Commission without sustaining damage or without particular difficulty at temperatures of 35 deg. fahr. below zero.

The savings effected in the cost of cement alone by the application of the methods of control worked out have been very great. An equally important result which followed the demonstration that close control of quality was possible, has been a reduction in the factors of safety formerly set by the Engineering Department for concrete structures. During the past 18 years a progressive increase in the 28-day compressive strength of concrete from 1,700 to 3,500 lb. per square inch has been obtained with no increase in the cost of construction.

*Wooden Transmission Structures*

A subcommittee on Wooden Transmission Structures was appointed to continue work begun by the Laboratory and Operating Departments on the subject of wood preservation. This work had been proceeding for about ten years but on a restricted scale. The first major step was the establishment of test beds in soils known to be destructive to poles. The initial installation consisted of about 60 poles of different woods and treated in different ways. There are now two test beds where approximately 150 poles are under observation. In addition, a program of inspection has been applied to a group of several hundred poles in various parts of the systems, selected so as to permit a study of the effects of such factors as age of pole, kind of wood, type and method of preservative treatment, type of soil, etc.

The subcommittee has also developed a method of treating poles in service, to prevent decay at the ground line. The equipment consists of a metal collar surrounding the pole and supported so as to form an annular space in which a mixture of sand and creosote is placed. The methods of construction and application are fully described in a specification prepared by the subcommittee, which has been adopted by the Engineering Department and issued as standing instructions for the treatment of old and new poles. It possesses the advantage of cheapness, and does not,



*New Equipment for Testing Lubricating Oils to the point of breakdown of film strength.*

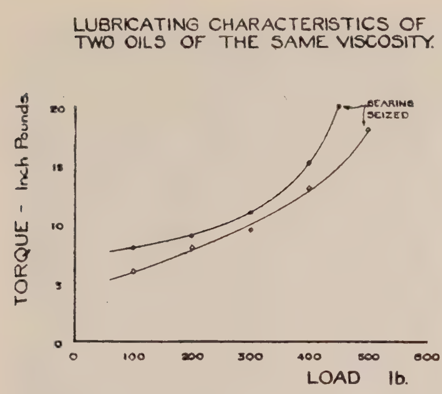
when installed, reduce the area of contact between pole and soil.

Up to the present time approximately 285,000 poles have been treated in this way, and it is estimated that their life may be extended about ten years. The possible saving in pole replacement, if this result can be realized, is very great.

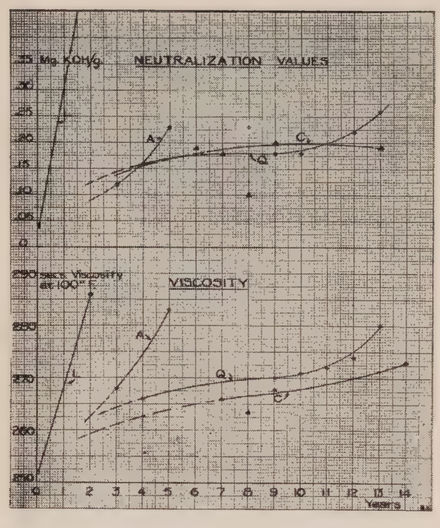
Studies are also being made of native trees, such as spruce and jack pine as possible materials for poles. It is highly desirable to use such woods, which are plentiful in many districts, where transportation costs are high and cheap construction necessary. The development of means for combatting the attack of destructive ants is also an important concern of this subcommittee. A method of stubbing poles has been developed, in which use is made of a steel cylinder surrounding the pole and containing a cement-sand mortar. This produces a setting of high strength and avoids the necessity of installing wooden stubs in locations where they would be unsightly. It has the important advantage that the pole may be loaded immediately after the stubbing operation.

*Paint and Protective Coatings*

The testing of paint has been carried on systematically for over 15 years, and methods have been developed which permit of a speedy appraisal of the quality of paint submitted for any application in which the Commission is interested. Accelerated tests on the weatherometer are supplemented by exposure tests and observation of paints in service. Paints having known properties of life, workability, etc., are used to




*Lubricating Characteristics of Two Oils of the same viscosity,—information obtained from the new oil test equipment.*




*Changes in Lubricating Oil with Service. The results of tests on samples from generators in different stations.*

check the results. Experience accumulated over a period of years in this way has resulted in a standardized method of purchasing.

In ordering paint, the field man or department concerned, specifies the service required and the Purchasing Department orders from a list of approved brands, which has been prepared by the Laboratory in co-operation with the Paint Committee. New brands or types must be submitted to the Laboratory, pass the tests, and be approved by the committee before they can be added to the list.

The Laboratory maintains a check on the quality of paint supplied, by selecting samples from shipments and comparing them with the samples originally submitted for approval.

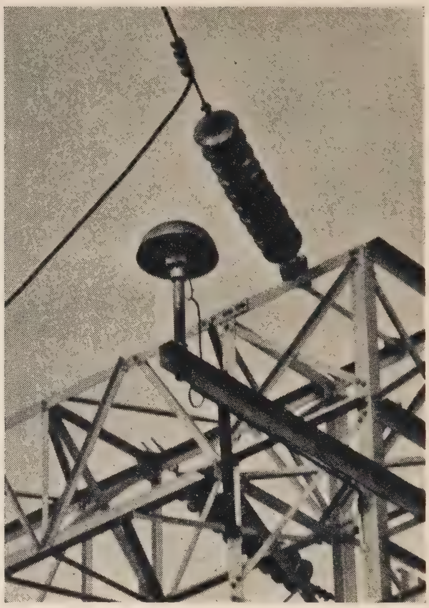
Studies of painting methods in the field have produced marked savings, in particular in the painting of steel towers and in the maintenance of penstocks.

*Oils*

The study of insulating and lubricating oils and of greases embraced in the term "petroleum products"—is the duty of another subcommittee. A schedule of testing lubricating oils in generating plants was instituted when the Queenston plant was opened and the records obtained from this, and other plants, have yielded information about the deterioration of oils in service which has suggested methods of treatment.

A practical result of these studies has been a reduction in the number of oils carried in stock in the various stations. It is probable that a standardized method of purchasing may be eventually worked out for lubricating oils as in the case of paint. In the case of insulating oils this has been accomplished. This material is

*Potential Indicating Device for Live Lines, with voltmeter for switchboard mounting.*



*The Capacity-type Potentiometer mounted on a switch structure.*

now purchased directly from the producer under specifications, and not from the manufacturer of electrical equipment.

Studies on the reconditioning of insulating oil are also being prosecuted and while finality has not yet been reached, progress so far has been satisfactory. Other studies of this subcommittee have included: lubricating oils and fuels used in the operation of diesel engines; field tests on flexible extension chambers as breathers for certain types of transformers; studies of greases with a view to determining their film strength, behaviour in contact with water in bearings, and consistency at various temperatures. The Laboratory is also investigating a new friction tester for determining the value of lubricating oils. It is hoped that this may develop into a method of comparing lubricating oils for various service.

*Rural Applications of Electricity*

Another subcommittee is engaged in studying new methods and equipment whereby electrical power may be more widely applied in agriculture and floriculture. Electric soil heating has formed an important part of this study. Several installations in greenhouses throughout the province are being observed and the subcommittee is co-operating with the Ontario Agricultural College in studies carried on there in electric soil heating and in the application of artificial illumination to floriculture. Other studies being conducted include small

grinding mills, electrically heated pig brooders, and the pasteurization of milk.

*Grounding*

This subcommittee was recently appointed to continue to correlate studies previously made by former committees and by various departments of the Commission. All technical matters concerned with the problem of grounding will be the concern of this subcommittee. It is at present actively studying grounding methods, particularly the application to districts where low ground resistance is difficult to obtain.

*Miscellaneous*

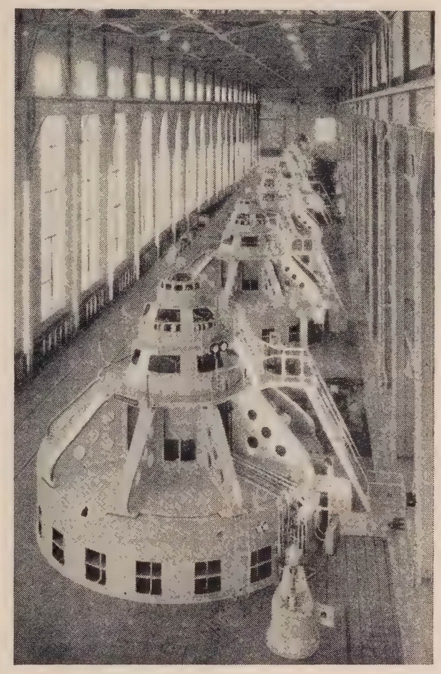
The following list of studies now underway under the auspices of other subcommittees will further indicate the range of work being carried on:

*Methods for controlling loads* from remote points with particular reference to water heater and range loads.

*Heating Elements* and electric cooking including the investigation of characteristics of heating and cooking elements and their control with the view to improving design and suggesting new applications.

*Treatment of Water.* This has included methods for preventing corrosion in water tanks and cooling systems, troubles due to algae growth in cooling ponds at transformer stations, the effect of composition of water on concrete structures, etc.

*Electric Welding.* A study of the methods of welding and advancements in the art; methods of testing finished welds, the determination of properties of new welding rods appearing on the market; a study of the impact characteristics of pure weld metal deposited from various electrodes in use by different manufacturers; investigation of methods of turbines and centrifugal pumps. The information obtained is applicable in the inspection of fabricated parts of equipment where heating is used.



*The 23,500 kv-a. generators in the Chats Falls development. The factory inspection of this type of equipment is done by the Laboratories, and also electrical acceptance tests are witnessed.*

*The Applications of Electronics* to the Commission's Systems. This field is obviously very wide. Special attention is being given at present to the use of carrier frequency current for relaying, telemetering and kindred uses.

*Joints in Electrical Conductors.* This subcommittee has just been

organized to study the difficulties encountered in the field with joints in aluminum cables.

Not all the investigational work is carried on by means of committees. The items mentioned above involve continuous attention and the committees are permanent. In addition, the Laboratory department undertakes special tests and investigations of an extensive and miscellaneous character, the demand for which arises in operating problems.

Lightning was the cause of particular concern, when the first 220 kv. lines were placed in operation. Considerable attention was devoted to the study of lightning voltages and attenuation factors and the merits of palliative measures. It was decided to reduce resistances of the tower footings to as low a value as possible and every tower in a 3-circuit line extending from Toronto to the Ottawa river, a distance of 200 miles, was measured and treated. Since the line traversed rocky country in a portion of its length, the securing of low resistances offered some difficulty. Satisfactory results were, however, obtained and little trouble has been experienced from lightning since the line was placed in operation. The study of disturbances caused by lightning, switching or other phenomena is facilitated by the installation in Leaside Station, Toronto, of a graphic klydonograph and a 9-element automatic oscillograph.

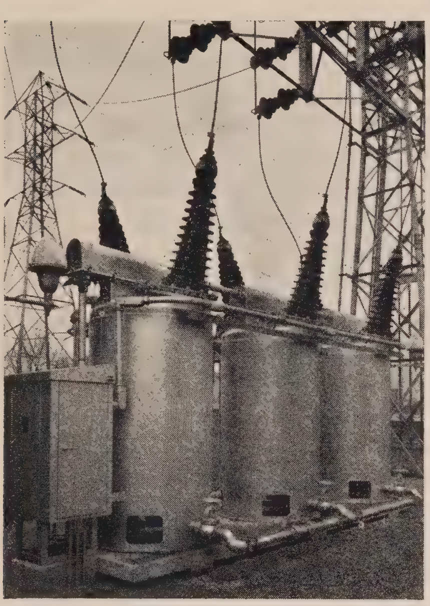
Problems of inductive co-ordination have at times involved investigations in co-operation with communication companies. Radio interference involves co-operation with a Department of the Federal Government which in Canada controls radio-broadcasting and which maintains a staff to investigate complaints of interference with broadcast reception. The Laboratory is a party to these investigations in so far as they involve the Commission's circuits. In addition to investigating these complaints, it has appeared prudent to take steps to assure non-interference with new apparatus installed by the Commission. This is done by determining the threshold or minimum voltage at which objectionable radiation may be propagated from any given type of apparatus. These values are listed in a manner in which they may be used by the Engineering Department in designing lines. This problem is also one which the manufacturers of appliances must attack, since information available indicates that appliances are probably responsible for most of the trouble.

I have endeavoured to emphasize in the preceding discussion that the aims of the research work undertaken are eminently applicable. Improvement in materials and equipment used by the Commission and in methods of operation will increase the general efficiency of the organization. The studies dealing with the application of power are directed towards increasing the Commission's load.

### Summary and Conclusions

The results of this investigational work may be grouped under the following heads:

1. The development of standards of quality which eventually become purchase specifications. This fol-



*A typical oil circuit breaker inspected during manufacture. This equipment also is given operating acceptance tests at the factory with a Laboratory representative as witness.*

*Transmission line towers are inspected by the Laboratories during fabrication, special attention being given to quality of material and galvanizing. Loading tests on a specimen tower are made and witnessed by the inspector.*

lows from studies of the properties of materials and equipment and of their behaviour under operating conditions.

2. The development of equipment for special applications.
3. The development of standards of practice which are translated into operating instructions. This follows from the study of methods of using materials.
4. The collection of information about the conditions of equipment, its behaviour in service and defects in design revealed in operation furnishes the manufacturer with data upon which to base improvements in his product. The securing of this information is obviously the concern of the utility.

It is believed that this method of carrying on investigational work is well suited to a large electrical utility such as the Hydro-Electric Power Commission, and that advantages have accrued to the organization, which would have been delayed or lost in the absence of the scheme. An important advantage results from the enlisting of a group of Engineering and Operating representatives in any project. Such a group acts as a guide to the Research Department and assists it in accumulating information from the field and in avoiding unprofitable lines of attack. Again, the scheme provides a means whereby

ideas conceived by any member of any department may quickly be appraised and developed. Recommendations based upon the study of a group representing all interested departments become translated into executive action more promptly than they otherwise would.

The cost is not great compared with the potential benefits, and in many cases it has been possible to point to actual savings far in excess of the original outlay in research. In fact, it is estimated that the savings effected in materials and methods of construction and in operation during the past 15 years, by the studies on three projects, have been greater than the amount spent on all research work during that time.

The benefits resulting from a systematic program of testing and inspection have been discussed earlier in the paper. These may be summarized in the statement that such a program assists the organization in obtaining the best value for its investment, and in rendering satisfactory service to the consumer, by securing materials and equipment of proven quality and by giving the maximum possible assurance of reliable performance during the life of the equipment.

It may thus be stated with confidence that a large electric utility will be well repaid by the results of a comprehensive policy of testing, inspection and research, carried on by a staff having an intimate knowledge of the organization and sharing responsibility for its efficient operation.

# D. C. Polarity Reversal of Exciters

**By H. S. Baker, Meter Superviser, H.E.P.C. of Ont.**

WHERE exciters feed the generator fields with no rheostats between it is not uncommon for the exciters to reverse polarity when cut down from running voltage to zero voltage in taking them off load. It is also not uncommon for the exciters that do reverse, to behave in an unstable manner on hand control of voltage, when raising the voltage from zero to running value.

The cause of the above instability has been located as due to d.c. armature reaction overpowering shunt field excitation on reduction of d.c. voltage to zero in cases where an inductive load causes the d.c. amperes to continue for a short time after the d.c. volts have reached zero. The armature reaction in a d.c. generator tends to *buck* the shunt field excitation when the brush position is set too far from normal position in the direction of rotation (or given too much "lead"). The armature reaction tends to "*boost*" the shunt field excitation when the brushes have too much "*lag*".

For d.c. generators without inter-

pole windings, it is often necessary to give the brushes a "lead", to reduce brush sparking at full load.

For d.c. generators with properly designed or properly adjusted interpole windings, the brushes do not need to be given this lead.

The brush position giving minimum sparking at no load, is called the "no load neutral". The position giving minimum sparking at full load is called "full load neutral". The brush position giving "zero mutual inductance" (as explained below) between the armature winding and the shunt field winding, is called the "kick neutral", and closely agrees with the no load neutral point.

For ordinary d.c. generators without interpole windings, a brush position is chosen somewhat nearer the full load neutral than the no load neutral.

For d.c. generators having interpole windings the three neutral points agree closely, and the brushes should be set on this point.

However, it happens that d.c. exciters feeding the highly inductive circuits of a.c. generator fields, sometimes have their brushes erroneously set to a "lead", sufficient to cause polarity reversal. The presence of the "lead" setting causes the d.c. armature reaction to *buck* the shunt field excitation, and upon reduction of shunt field current to zero, the a.c. generator field inductance causes the d.c. armature amperes (and the d.c. armature reaction) to continue for a short time, thus reversing the exciter field magnetism.

This same d.c. exciter (even with excessive brush lead) if feeding a load whose armature amperes arrived at zero as soon as the d.c. volts arrived at zero, would not reverse polarity on reduction of d.c. voltage.

In order to accurately and conveniently determine the "kick neutral" brush position, or the position giving zero mutual inductance between the armature and shunt field winding, proceed as follows:

With the exciter standing still, connect a d.c. voltmeter (say 3 volt scale) across the shunt field. Apply a few amperes d.c. through the armature from plus to minus brushes, from a single dry cell or otherwise, and suddenly cut the amperes off. If the brushes are not set on the "kick neutral", a kick will be noted on the voltmeter. Now shift the brushes until no kick shows, and mark this brush position as "kick neutral".

# 1 Man = 420 Kw-Hr.

IN his new book, "Nine Chains to the Moon", R. Buckminster Fuller, the imaginative engineer who designed the radically different Dymaxion car and house, describes man as .... "a self-balancing, twenty-eight jointed, adapter-base biped. An electro-chemical reduction plant, integral with aggregated stowages of special energy extracts in storage batteries, for subsequent actuation of thousands of hydraulic and pneumatic pumps, with motors attached. Sixty-two thousand miles of

capillaries; millions of warning signals, railroad and conveyor systems; crushers and cranes . . . and a universally distributed telephone system needing no service for seventy years if well managed. The whole . . . mechanism guided with exquisite precision from a turret in which are located telescopic and microscopic self-registering and recording range finders, a spectroscope, etc., the turret control being closely allied with an air-conditioning intake-and-exhaust, and a main fuel intake . . . "

But this man, continues Mr. Fuller, as a machine, is hardly worth even the 69 cents or thereabouts that chemists charge for the elements from which his body is built. Let's see what he really does amount to. Consider a husky American performing every working day the equivalent of carrying a 50-lb. pack 3,000 ft. up a mountain slope. His day's output is then 0.057 kilowatt-hours. If he works five days a week and fifty weeks a year, allowing two weeks off for sickness or vacation, this will amount to about 14 kw-hr. in a year or 420 kw-hr. in a working lifetime of thirty years. If he sold his energy at a low wholesale rate of 3 mills per kw-hr. now charged for hydro-electric power in some areas, he would earn $1.26 in his lifetime. But this rate may be too cheap, so let's grant him a retail rate of as high as 6 cents. Then his thirty-year output would bring $25.20.

It's pretty obvious from this comparison that man just isn't fitted to haul loads up mountains—or to compete with power-generating equipment in energy conversion. But fortunately, this computation neglects the worth of what Mr. Fuller describes as the "turret", and details more fully thus: "Within the few cubic inches housing the turret mechanisms, there is room also for two sound-wave and sound-direction finder recording mechanisms, a filing and instant-reference system, and an expertly devised analytical laboratory large enough not only to contain minute records of every last and continual event of up to 70 years' experience . . . but to extend, by computation and abstract fabrication, this experience with relative accuracy into all corners of the observed universe. There is, also, a forecasting and tactical plotting department for the reduction of future possibilities and probabilities to generally successful specific choice".

The difference between man and other machines is that man can think. He is better fitted to design, build and operate the train that hauls loads up a mountain than he is to haul them himself. He is better fitted likewise to operate power-generating devices than to generate power.

These are simple and generally agreed-upon statements, but facts often forgotten. Most physical jobs, like handling coal, pumping water, and generating steam, machines can do better than man, providing that man is there to direct them. Our task now is a continuing one, to use the turret instead of the prime mover, to think and to control instead of to labour. It is a work of synchronization, synchronizing man and power to work together for mutual gain to both.—*Power.*

# Twenty-Five Cycles

THE adoption of twenty-five cycle frequency for power generated at Niagara Falls was the result of consideration of proposals of the Niagara Falls Power Company to develop electrical power for long distance transmission. The word "Power" in the incorporated title of the company indicated that the purpose of the incorporators, as explained in their charter, was to develop power for use in manufacturing and transportation at and in the vicinity of Niagara Falls and Buffalo, New York.

While lighting was considered as one form in which power from the proposed electrical development might be used, its use by 10,000 inhabitants of Niagara Falls was thought to be of relatively small importance. There was also but little use for power in Niagara Falls as there were yet but few industries there. In Buffalo, however, there were 250,000 inhabitants widely engaged in manufacturing, and who had recently expressed their desire for Niagara power by offering a cash bonus of $100,000 if it were brought to their city.

The first real step towards this end was made in 1889 when the Cataract Construction Company was incorporated. Under the direction of its president, Edward Dean Adams, it organized the International Niagara Commission consisting of five eminent scientists of Europe and the United States, with Lord Kelvin as Chairman,—"to conduct a scientific symposium on the development of power at Niagara Falls which would attract the best scientific and engineering knowledge and experience of those competent to be found in the nations of the world". After exhaustive studies this Commission recommended the electric method, utilizing the polyphase alternating current system.

Alternating current at that time was in its infancy. It had made its appearance in a crude form in Italy in 1885. George Westinghouse, having learned of it, took steps to obtain the American rights on the fundamental principles and arranged for William Stanley and his associates in Pittsburg to conduct experiments to prove the feasibility of a commercial power system using alternating current. Early in 1886 the transformer had been developed and the feasibility of the system established.

In the use of alternating current, it was found that a comparatively low rate of alternation, or periodicity, favoured the use of the current in large motors and for the operation of rotary converters for changing alternating current into direct current for the operation of street railways and for other special purposes. An increase in the number of cycles per second made the current less desirable for power purposes, although the higher frequencies were more suitable for incandescent and arc lighting.

Westinghouse was probably the first man of strong influence in electrical development to realize the importance of adopting and adhering to a standard frequency of alternations.

It had been shown that direct connection of alternating generators to the reciprocating engines, then in general use, was very difficult, if not absolutely impracticable, unless a frequency much lower than 133 cycles was adopted. Westinghouse gave instructions for an investigation of the subject, and before the end of 1892, two frequencies were selected as standards for the Westinghouse Company: 60 cycles to be used where the principal load was for lighting, and 30 cycles where a large part of the power was to be converted and utilized in the form of direct current.

At this time, the Niagara Power development was beginning to take form, which lead to considerable discussion among engineers regarding the frequency to be adopted for the proposed plant. The power company already had placed its order for hydraulic turbines to run at 250 revolutions per minute. This fact forced the Westinghouse Company to choose between a sixteen pole machine which would produce 33-1/3 cycles and a twelve pole, which would give 25 cycles. The sixteen-pole, 250 rev. per min. machine giving 33-1/3 cycles was as near to the Westinghouse proposed standard frequency of 30 cycles as it was possible to get.

Professor George Forbes of England, one of a commission considering the Niagara power development, first expressed a decided preference for 8-1/3 cycles per second; but in the summer of 1893, when he submitted his suggestions, it was particularly noted that the design provided for a frequency of not over 16-2/3 cycles per second; this increase in frequency then appearing to him to be necessary for a sound mechanical design. He favoured the very low frequency for the following reasons:—

By lowering the frequency, parallel working of machines would be assisted, although with the lower frequency the transformers must be increased in size.

The 16-2/3 cycles was considered the most favourable as a motive power when considering dynamos and motors. Ordinary continuous current dynamos of any size may be used as synchronizing motors by means of rings attached to the commutator bars: but the greatest advantage is in the improved efficiency of the motors.

Commutating devices are better at low frequency than at high.

He believed that perhaps the greatest advantage of low frequency was in connection with the line,—less trouble with capacity of cables and induction in neighbouring telephone circuits is utterly inappreciable at such a low frequency.

Regarding the disadvantages—Professor Forbes admitted that such a low frequency was not suitable for direct electric lighting, but believed that this was of little importance in the Niagara plant, having in mind a decided preference to convert the current.

From experiments made by himself, Professor Forbes found that a 16 candlepower, 50 volt incandescent lamp shows a flickering up to 25 cycles, but if pushed to excess of incandescence it is perceptible up to 27 or 28 cycles. He stated that this

flicker is not nearly as serious as that due to the variable speed of certain types of engines; the thinner the filament, the greater the liability to flickering.

The Westinghouse contention was that this frequency was too low for any kind of service except possibly commutator type machines. Tests were made with incandescent lights and it was found that at 33-1/3 cycles there was little or no flickering of light, while at 16-2/3 cycles the flickering was extremely bad. Tables were also made up showing the limited number of speed combinations at 16-2/3 cycles for induction motors, then being developed, in case such should come into use. This showed how superior the 33-1/3 cycles would be as regards such apparatus. It was also brought out that synchronous converters, when such became commercial, would be much better adapted for the higher frequency, as the choice of speeds would be greater.

In the course of the negotiations, there was a dinner conference at New York at which the details of the proposed contract between the Cataract Construction Company and the Westinghouse Electric and Manufacturing Company were discussed at length. The construction company insisted upon 16-2/3 cycles and a guarantee of efficiency in operation, while the Westinghouse Company expressed an unwillingness to give its guarantee upon any frequency less than 30 cycles. Before the diners separated a question was asked, which was substantially as follows:—

Can the Westinghouse build a satisfactory alternator which would deliver current at 25 cycles, the efficiency of which would be guaranteed by the Company?

It was finally agreed that the generators would have twelve poles and the result was 3,000 alternations, or 25 cycles, this being the lowest frequency for which the Westinghouse Company would guarantee sound mechanical design.

The Niagara generators were designed and developed in detail in 1893 and built the following year. The Niagara Falls Power Company having definitely standardized 25 cycles as the frequency for power generated by it, this same frequency was adopted by other plants later established at Niagara Falls and it has thus become the standard frequency for all stations on the Niagara river.

* * * *

The Bulletin acknowledges assistance in the preparation of the foregoing from:—

"The Niagara Plant".—By Professor Forbes, Electrical World, 1893.

"Life of George Westinghouse".—By Prout.

"The Technical Story of the Frequencies".—By B. G. Lamme, A.I.E.E. Transactions, 1918.

"Niagara Power: History of the Niagara Falls Power Company 1886-1918".—By Edward Dean Adams.

"A Half Century of Engineering Progress".—By H. W. Cope, The Electric Journal, January, 1936.

Benjamin Garver Lamme, Autobiography.


*First Prize, Class 1, Toronto Hydro-Electric System.*

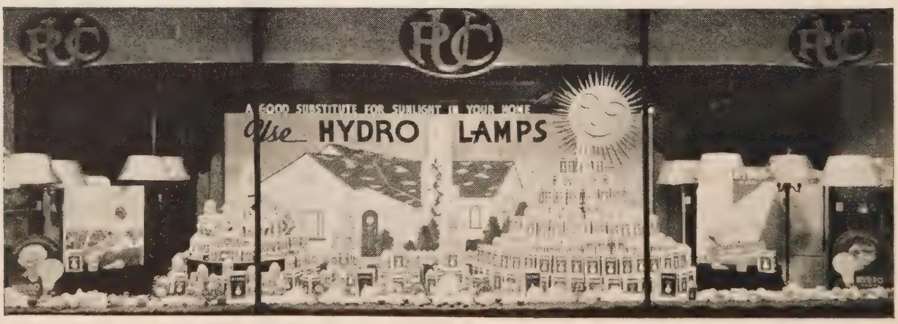
# Hydro Lamp Window Dressing Contest Awards

## Class 1

THE 1938 Annual Hydro Lamp Window Dressing Contest was a success both as to the number of entries in all four classifications and the excellency of the displays created.

The interest in the contest increases with each year and the Hydro shop staffs look forward to the opportunity of creating competitive Hydro Lamp window displays.

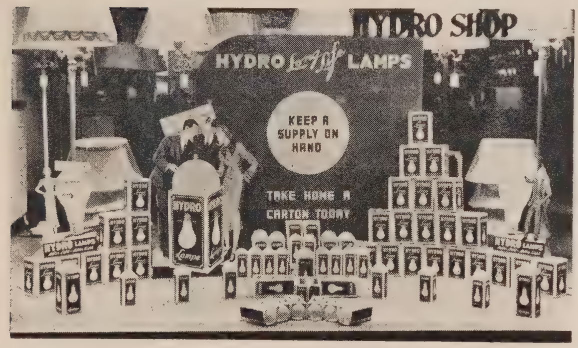
Displays such as depicted here were



directly responsible for a gratifying increase in the sale of Hydro Long Life lamps.

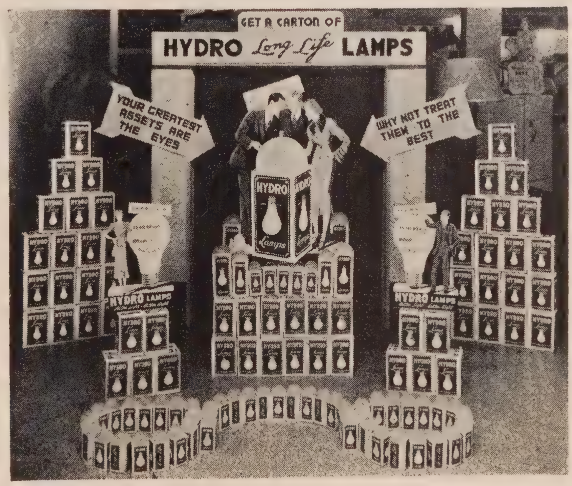
The winners in Class 1, large cities, are reproduced herewith. The winners of the other classes will be shown in subsequent issues.


*Tie Third Prize, Class 1, Hamilton Hydro-Electric Commission.*




*Tie Third Prize, Class 1, Store No. 1, Hydro Division, The Windsor Utilities Commission.*

*Right—Tie Third Prize, Class 1, Store No. 2, Hydro Division, The Windsor Utilities Commission.*




*Opposite — Second Prize, Class 1, The London Public Utilities Commission.*

# Rectification—A Survey

By H. J. Chambers, Toronto Hydro-Electric System

STRICTLY speaking, the term "rectification" covers any method whereby an alternating current is converted to a direct current, and includes therefore, rotating equipment; but as the term "rectifier" has become synonymous with various types of static devices, this article is confined to consideration of that type. This does not mean that rotating converters are completely out of the picture, as there are certain fields in which they are still predominant (such as arc welding and other applications where a very heavy current at low voltage is required) but in the power field and for most industrial applications the static rectifier has been gradually supplanting rotating equipment, there being now well over four million kw. of rectifier equipment in operation in the world.

In general, power rectifiers can be divided into two groups, namely:

1. Vacuum, or more strictly speaking, low pressure vapour apparatus.
2. Non-vacuum group.

Considering, briefly, the non-vacuum group first, this may be sub-divided as follows:

1. Mercury-jet apparatus.
2. Gas cooled arc types.
3. Hydionic converters.
4. Mechanical rectifiers.

Most of the non-vacuum types are merely synchronous interrupters and are free from polarity limitations, but generally involve numerous auxiliaries or rapidly moving parts and consequently have some of the inherent disadvantages of rotating equipment. On the whole, their efficiency, reliability, and economy are lower than those of the mercury-vapour devices.

By far the greater amount of installed equipment comes under the first general group, i.e., low pressure vapour apparatus. Power rectifiers are almost entirely in this group, and accordingly, this article will deal more fully with the so-called vacuum type.

The various forms of vacuum, or low pressure vapour apparatus met with, are as follows:

1. Hot-cathode rectifiers.
2. Water-cooled mercury-pool types.
3. Air-cooled mercury-pool types.
4. Igniter types.

The first group favours either glass or glass and metal construction of the vacuum vessel; the second group, all metal; the third group, all glass or all metal; while the igniter type can be either of glass or metal construction. Of these different groups, the air-cooled, pumpless all-metal design and the igniter types represent the most recent progress in their respective fields together with the application of grid control.

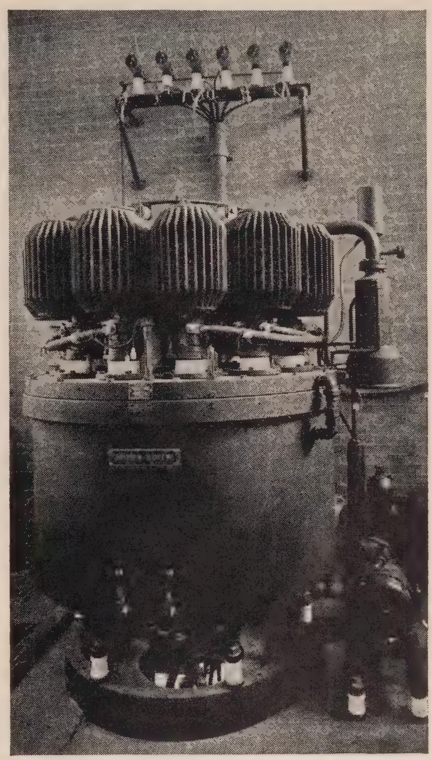
### Hot Cathode Rectifiers

Although fundamentally it is easier to obtain very heavy currents from a mercury-pool cathode, hot cathode rectifiers have been developed for out-

puts up to 275 amperes at 7,500 volts. The most common use for this type at the present moment is for plate supplies in radio stations, and for such work there is a series of rectifiers giving an output of 1,000 volts at 500 milliamperes, up to 20,000 volts, 20 amperes. There are several sets in operation at various radio stations delivering about 10 kv. at 10 amperes from a 3-phase supply. This type is also being developed for use in X-ray applications, the tubes having an output of several hundred milliamperes at 100,000 volts. The reliability of this equipment can be very high, arc backs being met with only at the end of life, and the life being of the order of 4,000 to 10,000 hours.

Oxide cathodes are most common because of their great efficiency. The power taken by the cathode varies considerably but generally speaking a 3-phase full wave equipment having an output of 12 amperes at 10 to 20 kv. will have a total cathode power of about 600 watts. As the anode-cathode drop when current is passing is about 8 to 14 volts, it can be readily seen that such equipments have very high efficiencies. Since the operation depends upon the presence of a certain quantity of liquid mercury, certain limits of mercury pressure must be maintained, and as the space within the tube is saturated with mercury vapour the pressure depends on the coldest spot on the tube.

For the smaller tubes the temperature range is wide and no special precautions are required in temperate climates. In the larger tubes the range is narrower than the temperature range of the enclosure and temperature control must be maintained. In such cases, air maintained at the required temperature by a heater and thermostat, is directed at the base of the tube.



*Water cooled metal tank rectifier.*

### Mercury-Arc Rectifiers

For power applications the mercury-pool, or, as it is more commonly known, the mercury-arc rectifier, still reigns supreme. There are many types of this equipment on the market, all operating on the same fundamental principles and differing mainly in types of enclosure, methods of cooling, auxiliary equipment, etc. Both the glass bulb and the metal-tank types are now widely used for power applications. An interesting

glass bulb installation was described by J. H. Steede in "Electrical News and Engineering" for June 1, 1938, so that type will not be dealt with further in this article. To complete the picture, a typical metal tank rectifier installation will be described below, followed by a discussion of operating experience and of recent developments in the metal tank field.

### Typical Plant

The Ossington substation of the Toronto Hydro-Electric System is a two-unit automatic rectifier plant consisting of two 1,100 kw., 600 volt water-cooled metal tank rectifiers, each rectifier equipped with high and low vacuum pumps. The supply voltage is at 13.2 kv., stepped down through a 13,200/562 volt 1,100 kv-a. transformer (one for each rectifier), having a double six-phase secondary, the neutral point being connected to negative through an absorption reactance which also acts as a regulating device.

The plant incorporates the following automatic features: (1) It will start automatically at a pre-determined d.c. bus voltage or, of course, by manual control. The starting process consists, in sequence, of (a) the closing of the a.c. circuit-breaker, (b) ignition, and (c) the closing of the d.c. circuit-breaker. (2) It will be disconnected at a pre-determined low load value. (3) The rectifier is protected against continuous overloads by a thermal relay and against overloads and short-circuits by three overcurrent line relays and one overcurrent ground relay, the thermal relay setting being lower than that of the overcurrent relays. If tripped by overload or short-circuit, it will reclose after each tripping (if the overload or short-circuit condition continues), for a pre-determined number of times at pre-determined time intervals; and will be locked out if tripped after the last closing cycle.

The rectifier is protected against overheating by a temperature relay (contact thermometer), located at the rectifier cylinder. Excessive temperature causes the temperature relay to energize a lockout relay which in turn trips and locks out the a.c. breaker. Upon failure of the cooling water, a water interruption relay energizes the lockout relay through a timing relay, so that if the water flow is not restored within one minute the a.c. breaker is locked out.

The vacuum pump operates automatically to maintain the vacuum in the rectifier at the required value, independent of the operation of the rest of the plant. The operation of the pump is controlled by a vacuum meter which is actuated by a hot wire gauge located in the vacuum piping to the rectifier. When the vacuum drops below a predetermined value the pump is started up and runs until the vacuum reaches the required value. If the vacuum remains too low for proper operation the lockout relay is energized and the a.c. breaker tripped and locked out. In all cases the lockout relay must be reset manually.

Over-voltages liable to cause flashovers and service interruptions may occur in rectifier plants between the anodes themselves and between the anodes and the tank, especially when

the rectifier is still cold. To protect against flashovers each of the anodes is connected through a separate horn arrester and damping resistor to the neutral point of the six-phase system. Associated with the horn arresters and damping resistors is an equalizing resistor which is connected across each double secondary winding.

### Operating Experience

The plant has been in operation for about eight years and on the whole the service has been very reliable. As far as the rectifiers themselves are concerned it would appear that the auxiliary equipments are the chief sources of maintenance trouble, particularly the vacuum pumps. It seems evident, therefore, that the elimination of any of this equipment would be a definite step forward.

### Metal Tank Developments

The lower economic limit of water-cooled steel tank rectifiers is about 1,000 amperes. It is recognized that if the efficiency could be maintained and the number of auxiliaries reduced, the steel tank would fulfil many applications for currents of the order of 500 amperes. Commercial rectifiers of the air-cooled pattern with pumps have been produced in a very compact arrangement, but the general design adopted resulted in the current range in this rectifier being only about 170 to 400 amperes. To save space the vacuum gear is mounted on the same bed-plate as the rectifier but underneath the cylinder.

One of the most important of recent developments has been the elimination of the vacuum pump by the successful production of a pumpless steel tank rectifier which does not require frequent pumping during its life. One of the principal contributing factors has been the improvement in welding, particularly the development of the atomic-hydrogen process, which, coupled with a better understanding of the diffusion of gases through metal containers, permitted the construction of perfectly vacuum-tight vessels.

Vitreous enamel seals having already been developed for the anode and cathode insulation, the fitting of a suitable vacuum-tight sealing device rendered the all-metal pumpless rectifier a practical proposition. In order to determine whether the continuous "cleaning up" process resulting from the arc was essential to the effective working of the pumpless rectifier, one of the vessels was sealed off and operated after long intervals over a period of two years. No deterioration of the vacuum was found, so that the rectifiers are perfectly suitable for working where intermittent loading is likely.

The general arrangement of this type of unit consists of a central dome around which are arranged the anode arms and auxiliary ignition anodes. The adoption of the side arm construction, with arm temperatures of over 200 deg. cent., permits a very effective dissipation of heat from the anodes, resulting in a high rating of the rectifier. In addition, the all-metal fabrication, besides its robustness and ability to withstand mechanical shock, permits the oblate dome construction with a large surface/volume ratio, facilitating the external attachment of radiators and air baffles. It thus becomes economical

to increase the rating per cylinder and so obtain an increased output per floor area. Because of the absence of the heavy metal parts and cooling liquid, the air-cooled rectifier soon reaches its normal working temperature, perfectly reliable starting being obtainable from 3 deg. cent. One interesting feature is the method by which the initial striking of the arc is effected. A fixed ignition rod is employed, thereby eliminating the complicated seal required for a moving rod, and the contact between the rod and mercury is broken by lowering a solenoid-operated cup.

Rectifiers of this type with cubicle arrangement, with and without grid control, have been built for current outputs from 250 to 750 amperes, while outputs of 1,000 amperes have been obtained under test conditions. A short-circuit of 20,000 amperes was applied to one of these units without ill effects. Voltage ranges are from 500 volts up to 3,000 volts and the question of still higher voltages is merely one of lengthening the anode insulators to suit the new conditions.

### Igniter Units

The "Ignitron" is the chief example of this type of unit and represents a recent phase in the development of the mercury arc rectifier. It is widely used for certain types of spot or resistance welding where specially timed impulses of short duration are required. The fact that the time lag (from the instant that the ignition impulse is applied, to the formation of the main arc), is less than 100 microseconds, permits half cycle welding currents to be readily obtained. Space does not permit a complete study of this type of apparatus further than to say that their application in industrial processes is rapidly expanding.

### Grid Control

The subject of grid control is a lengthy one, and a complete study of what is as yet a controversial subject, does not come within the scope of this article. Briefly, it might be said that the application of the control grid to mercury arc rectifiers provides a means of controlling the output voltage, but requires either a phase shifting transformer or some synchronous device. Grid control also permits the mercury arc rectifier to be employed as an inverter, i.e., for converting d.c. to a.c., and is made use of in d.c. transmission systems. —*Electrical News and Engineering.*

# Hydro-Electric Progress in Canada in 1938

THE annual review of hydro-electric progress in Canada prepared by the Dominion Water and Power Bureau, Department of Mines and Resources shows not only a substantial increase in new generating capacity but also widespread activity in the extension of transmission and distribution facilities. This has been particularly noticeable in many rural areas where electric service is now being made available to the farming community in constantly increasing degree. The rapid growth in the mining industry throughout the Dominion has also resulted in considerable activity in the extension of power facilities.

New water-power installations in 1938 aggregated 135,459 horsepower, bringing the total for the Dominion at the end of the year to 8,190,772 horsepower after this total had been adjusted following a general revision of plant ratings.

### British Columbia

The outstanding feature of new installations in British Columbia in 1938 was the extension of the Ruskin Station of the British Columbia Power Corporation on Stave river, where a second unit of 47,000 horsepower was completed and brought into operation towards the end of the year. Fraser River Golds Limited installed a 1,330-horsepower plant on Wahleach (Jones) Creek near Hope, and the Denver Light and Power Company Limited replaced its 75-horsepower plant on Carpenter Creek near New Denver with one of 129 horsepower.

### Manitoba

A fourth unit of 12,500-horsepower capacity was brought into operation by the City of Winnipeg Hydro-Electric System in the Slave Falls Plant on Winnipeg river, thus bringing the present capacity of the plant to 50,000 horsepower. The ultimate design provides for eight units with a total capacity of 100,000 horsepower.

### Ontario

The Hydro-Electric Power Commission of Ontario completed the construction of a number of generation and transmission projects. Investigations of new sources of power to meet future demands were also carried forward.

In the Georgian Bay System a new generating station was completed at Ragged Rapids on Musquash river about five miles below Bala. This station, which was brought into operation in October, has a rated installed turbine capacity of 10,400 horsepower consisting of two 5,200-horsepower units operating under a head of 38 feet. The turbines are of the movable blade type controlled by oil pressure from the governor.

In November, the Great Lakes Power Company completed and brought into operation a plant of 10,000 horsepower at Lower Falls on Montreal river. The Company com-

pleted a plant of similar capacity at Upper Falls on the same river last year. Both plants are interconnected with the Company's other developments at Sault Ste. Marie and Michipicoten Falls.

### Quebec

Installations in the Province of Quebec during 1938 included one new plant of 1,400-horsepower capacity and additions to existing plants of 42,000 horsepower.

Belleterre Mines Limited completed and brought into operation a 1,400-horsepower plant on Winneway (or Winawiash) river, a tributary of Lake Expanse in the north-western part of the province. The energy is being used for mining purposes.

Gatineau Power Company added a 34,000-horsepower unit to its Chelsea plant on Gatineau river increasing the installation of that plant to its designed capacity of 170,000-horsepower.

The Shawinigan Water and Power Company increased the capacity of its La Gabelle plant 8,000 horsepower by changing the runners of two units.

The Quebec Streams Commission maintained successfully the desired regulation of flow on controlled rivers through its extensive system of storage reservoirs in various parts of the province. The Commission now controls seventeen reservoirs on the St. Maurice, St. Francois, Gatineau, North, Ste. Anne-de-Beaupre, Mitis, and Lievre rivers and on Lake Kenogami.

### Nova Scotia

New hydro-electric installations in Nova Scotia during 1938 totalled 10,700 horsepower.

Construction of a new development at Cowie Falls on Mersey river about one mile from tide-water was commenced by the Nova Scotia Power Commission in September, 1937, and the finished plant went into operation on September 21, 1938. The installation consists of two vertical turbines with automatically adjusted blades, rated at 5,100 horsepower each under a head of 43 feet. The entire station is fully automatic in operation and is controlled from a base station approximately 10 miles distant.

The Minas Basin Pulp and Power Company completed the construction of its Salmon Hole development on St. Croix river. The installation of 2,770 horsepower was in partial operation before the end of 1937 and was included in the figures for that year. The new plant is interconnected with a 4,200-horsepower plant five miles downstream.

The Digby County Power Board carried out alterations to its dam and power station at Sissiboo Falls on Sissiboo river, involving an increase of head to 36 feet and the addition of a new unit of 500-horsepower capacity which went into operation on September 16, 1938.

# THE BULLETIN

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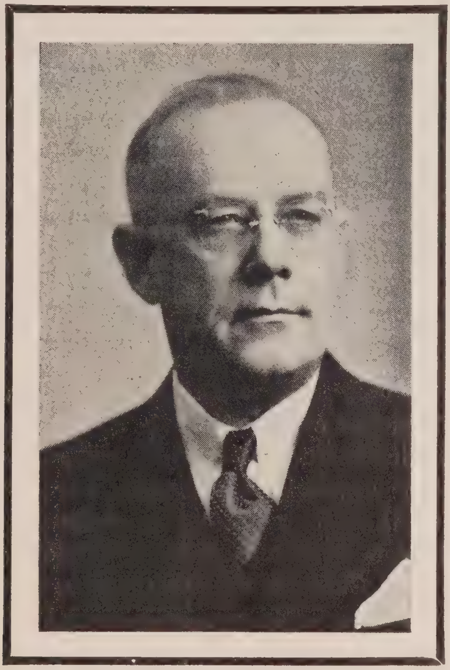

## William Hugh Mulligan

ON Wednesday, February 8th, it came as a great shock to his many friends and colleagues to learn that Bill Mulligan had died suddenly during the night. In splendid health at his office all the previous day, in the evening at a business dinner where he moved the vote of thanks, it seemed impossible that this kind and friendly man had passed on.

On January 17th, 1885, W. H. Mulligan was born at Chapeau, Allumette Island, Quebec. He spent his boy-

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**Vol. XXVI No. 2**
**February, 1939**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

hood in Chapleau, Ontario, where he saw the early development of the C. P. R. Later as a young man he attended Ottawa College and entered McGill University, taking his degree in Engineering. His early work on graduation was with the Montreal Light, Heat and Power Company, then Smith, Kerry and Chace and the Electric Power Company. For a short time he was manager for the Hanover Electric Company and joined the staff of the Hydro-Electric Power Commission in the fall of 1917.

Mr. Mulligan's early experience as engineer and manager made him eminently fitted for his chosen work in Employee Relations. He had an ability for taking infinite pains with detail and the patience to follow the detail sufficiently to develop practical information valuable and necessary in instruction and training. His engineering skill was of a high order. More recently as Chairman of the Working Committee on Job Classification and Wage Schedules, the breadth of his training and experience aided immeasurably in the exacting work of this committee.

In his contacts with the Public Utilities Section of the National Safety Council, Mr. Mulligan has left a record that will long stand. As Chairman of the Engineering Committee for a number of years he was responsible for some very important reports dealing with industry. One Pamphlet just completed and in the press entitled "Safe Handling of Poles" presents methods for handling poles from railroad car until after a useful life, the poles are replaced. He has left a niche that his co-workers feel will be difficult to fill.

It is, however, as a kindly, friendly man of character that he will long be remembered. The injured employee, the old employee out of a job, the men on construction, operation or rural work, full well knew that he would give an attentive hearing and also give sound advice and help where he could. Many a man who has helped possibly in a humble position to build Hydro, will long remember the helping, friendly hand extended by Mr. Mulligan when everything looked black. It is not without reason that his friends say to all the world "This was a man".

# Hydro Looks Forward

By Dr. T. H. Hogg, Chairman, The Hydro-Electric Power Commission of Ontario

## With Strong Financial Position, Increasing System Loads, and Ample Power Reserves, the Commission Plans Larger Promotional Effort to Increase Hydro Services Throughout the Province

IT is a pleasure to me to be able, this year, to attend your convention. Last year, to my great disappointment, I was unable to deliver in person the address which I had prepared for your midwinter gathering. In my absence my colleague, Mr. J. Albert Smith, very kindly delivered that address, which dealt at length with Ontario's power resources and requirements in relation to the Quebec power contracts settlement.

That was the culmination of an anxious time, a time of strain which involved the careful weighing of many proposals and counter-proposals, and finally resulted in momentous decisions. Happily, that time is behind us.

Last year, in rendering an account of our stewardship, it was necessary to deal very fully with the Commission's reasons for entering into those revised agreements, and I endeavoured to do so with the utmost frankness and completeness. There is no reason today either to retrace or enlarge upon the position taken then. Suffice it to say that the reception of the settlement of this important issue was heartening, and I believe the knowledge that a settlement had been effected came as a welcome relief to those who thought only of the best interests of Hydro. As I pointed out to you last year, the settlement was necessarily a compromise, and as such it obligated the Commission to take somewhat more power than it actually needed to take during the next few years.

Although I knew that the Commission's financial position was very strong, I also knew that for a few years difficulties might follow in the wake of the revised agreements. Substantial reductions in rates had been made during the previous year, so that load growth was necessary if the Niagara system was to receive sufficient revenue to continue to set up standard reserves. Can you wonder that I and my colleagues experienced some anxiety as we looked forward to what the next few years might bring?

Today, after the lapse of one of those years, I shall endeavour to record as simply as possible the present state of affairs. Many of you are

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An address delivered at the Winter Convention of the Ontario Municipal Electric Association and the Association of Municipal Electrical Utilities at Toronto on February 7, 1939.

particularly interested in the Niagara system and this, of course, is the system chiefly affected by the revision of the Quebec power contracts.

### NIAGARA SYSTEM LOADS

First, with regard to Niagara system loads: You know that a recession in industrial activity took place in the United States soon after the new contracts were signed and although this was not as serious in Canada, yet its effect, especially in the Niagara system, was noticeable. It is not surprising, therefore, that the growth in load during the succeeding year was not as great as the Commission, in 1937, looked for.

To obtain a proper understanding of load fluctuations in the Niagara system, it must be remembered that about four-fifths of the primary load represents the load supplied to municipal utilities, and the balance goes to large industrial customers of the system, supplied direct by the Commission, chiefly electro-chemical and electro-metallurgical industries in that small area along the Niagara river. These large industries are very sensitive to industrial conditions in the United States. Their load is the first to fall off at the approach of business recession, and usually comes back with suddenness when more normal conditions are restored. It reached a low level in March, 1938, and has recently been improving.

During 1938 and 1939 to date, the increase in high-tension municipal load has been partly offset by decreases in electro-chemical and electro-metallurgical loads just mentioned, but from March onward it is unlikely that this will continue to be the case. The winter peak of the high-tension municipal load was 6.2 per cent higher this season than the winter peak of 1937-38. As this municipal load provides the best barometer of general conditions throughout Ontario, and as from now on the full effect of its growth will be reflected in the revenue, this is a significant and important fact to bear in mind in thinking of the future.

### NIAGARA SYSTEM FINANCES

Let us now turn to financial considerations. During the fiscal year 1938, which closed October 31st last, there was an increase of two million dollars in the cost of purchased power resulting from the Quebec contracts settlement. This, of course, was foreseen when the agreements were revised. There was also a decrease in revenue attributable to rate reductions granted in 1937, before this Commission assumed office. These rate reductions were only effective for three months during 1937 as compared to twelve months during the fiscal year just ended. The difference in revenue collected as a result of this rate reduction, which is obviously in no way attributable to the revised power agreements, was about one million dollars.

It will be well to bear in mind that this reduction in revenue to The Hydro-Electric Power Commission of Ontario involves no actual loss to consumers; what shows on the books of the Ontario Commission as a decrease in revenue represents a gain to the Niagara system utilities which is ultimately passed on to the consumers in lower rates, or in other ways. Do not be misled by any comparisons be-

tween 1938 and 1937 revenue which represent this item as a loss. The money is not wasted. Although the Commission has received less revenue the municipalities have gained a like amount through obtaining lower cost power.

Despite this increase in Niagara system expense and decrease in revenue in 1938, the Commission was able to set up normal sinking fund and normal depreciation after meeting all operating and maintenance expenses. There was, however, a reduction in the amount available for other reserves. During the former year two and one-third million dollars were set up in a rate stabilization reserve and something over six hundred thousand dollars in the contingency reserve; in 1938 nothing will be set up in the rate stabilization reserve while the amount to be credited to the contingency reserve will probably be less than last year.

At the present time the Commission has over four and a half million dollars in its Niagara system rate stabilization fund. The fact that two and one-third million dollars were added to this fund from the 1937 revenue and nothing in 1938, need cause no alarm; I need not tell you that the rate stabilization fund was created for the purpose of stabilizing rates, not to be augmented year by year and every year regardless of the considerations which led to its creation. The significant fact is that so far as now can be determined there will be no occasion to make any withdrawal from the rate stabilization fund for the fiscal year 1938.

It is too early to speak with assurance about the results of the present fiscal year which ends October 31, 1939. We know there will be a further increase in the cost of purchased power amounting to one million one hundred thousand dollars. As against this there will be an increase in revenue attributable to the load increase already mentioned which should be more than sufficient to meet this increase in expense. The figures available to date indicate that this has actually been the case.

The fiscal year which ended last October and the present fiscal year are the two years in which substantial increases in power payments were called for under the Quebec contracts settlement, two million dollars last year and one million one hundred thousand dollars this year. But in the years that follow the scheduled increases will be small; in 1940 only three hundred and seventy-five thousand dollars and in 1941 two hundred and fifty thousand dollars. The significance of this is evident: after 1939 Niagara system surpluses over and above standard reserves should again resume their upward climb.

### Power Reserves for Emergencies

The Niagara system stands ready to serve any industry that may seek its power. Your power resources and your readily available power reserves are ample and I think the need for adequate reserves must now be established in the minds of all reasonable people.

The terrific ice jam in the Niagara river which shortly before your meeting last year brought down the Falls View bridge, flooded the Ontario

Power plant and disabled it for months while at the same time the output of the Commission's other Niagara river generating stations was curtailed so that the maximum simultaneous loss to the Commission in generating capacity approximately 255,000 horsepower, furnished dramatic and convincing proof of the need for power reserves. Another convincing proof was given nine days ago when owing to prolonged and violent winds and the presence of ice and snow, the flow of the Niagara river dropped to almost unprecedented volume. The river was so low that no water whatever was flowing across the spillway of the Toronto Power plant and that plant was virtually shut down. The aggregate simultaneous loss to the Commission in generating capacity was 310,000 horsepower, even exceeding the maximum loss in the previous year. While the maximum severity was only of a few hours duration, serious trouble prevailed for over half a day.

I do not cite these examples as evidence that the Commission requires a reserve of 310,000 horsepower in excess of primary demands, the question of the quantity of reserves required is complicated and was fully dealt with in my address last year. I mention these figures here solely as illustrations of happenings of extreme severity. Unavoidable losses in capacity of lesser amounts are much more numerous and it is these smaller losses which in conjunction with other considerations determine the quantity of reserves which is deemed to be appropriate.

May I just add here that my judgment of the merits of the Quebec contract settlement remains today what it was when the contracts were rewritten. It was a desirable and necessary settlement, and all things considered, the terms were favourable to this Commission.

OTHER SYSTEMS OF THE COMMISSION

As you will be hearing reports this afternoon from our engineers on various aspects of last year's operations, no lengthy comment by me on the other systems of the Commission will be required.

The winter primary peak of the Eastern Ontario system this year was nearly five per cent higher than the winter peak of 1937-1938. The peak load of the Georgian Bay system occurs in the summer months, and in 1938 this primary peak load was the highest ever carried. It occurred in the month of July and was 8.4 per cent higher than the peak load of the previous summer. In the Thunder Bay system due to the movement of the grain trade, the peak load in 1938 occurred in the month of September, and was the highest primary load ever carried by the Thunder Bay system. It exceeded the primary peak load of 1937 by 7.9 per cent.

Perhaps the most encouraging feature of the past year's operations was the growth in load in the districts served by the Northern Ontario Properties, which, as you know, are held and operated by the Commission on behalf of the Province. In these districts, which serve mining developments and the communities depending upon them, the primary peak load in December, 1938, was the highest on

record; it was 26 per cent. higher than the primary peak of December, 1937. As I pointed out at Port Arthur, Southern Ontario derives great indirect benefits from the rapidly growing activity in Northern Ontario.

One other encouraging feature of last year's operations was the continued phenomenal growth in the distribution of power to the rural power districts. The peak of the rural demand, which occurs in the month of August was 15 per cent. higher in 1938 than the corresponding load in 1937.

The total load in December for all systems and the Northern Ontario Properties, including both primary and secondary loads, reached 1,954,083 horsepower, the highest ever carried by the systems of the Commission. It was 9 per cent. above the December peak of a year ago.

I have already dealt with the financial results of the Niagara system. The year's operations on the other systems, and the amounts placed to reserves were satisfactory. After meeting all operating expenses, the Commission added to its financial reserves, including those for the Northern Ontario Properties, insurance, workmen's compensation, and staff pension provisions, a sum of about ten million dollars.

### Reduced Interest Rates

Striking evidence of the soundness of the Commission's operations and financial structure was provided twice during the year, when the Commission entered the financial market to refund old, and to issue new debentures. On February 1, 1938, a nine million dollar 4½ per cent. debenture issue of the Commission matured. It was refunded by a new 15-year issue that effected a saving in interest charges of some $80,000 per year. Later in the year the Commission issued twelve-and-a-half-million dollars of ten-year debentures at the extremely low net cost of only 3.27 per cent. Both issues were guaranteed by the Province, and were sold under competitive tender. The favourable results secured by these issues surely reflect the confidence of the investing public in the inherent stability of the Hydro undertaking.

### Improved Financial Status of Municipal Utilities

Before leaving the subject of financial progress, I desire to refer to the steady and very satisfactory improvement in the financial status of the municipal Hydro utilities, and to offer a special comment and warning in relation thereto.

During the past few years, in fact right through the depression, the assets of municipal Hydro utilities have continued to increase, although the slowing up of industrial growth naturally resulted in smaller annual investments in extensions to distribution plant and equipment. While these assets have been increasing it is very encouraging to note that liabilities have been decreasing. The liabilities of the municipal utilities reached their peak of about 53 million dollars in 1932, but since that time they have decreased each year until at the present time they are below 37 million dollars. In other words, during the past six years municipal Hydro utilities have decreased their liabilities by

about 16 million dollars, while increasing their assets by some 33 million dollars.

This remarkable improvement in financial status during a period which includes a major economic depression is certainly impressive. And it holds great promise for the future. We see that more of our local Hydro utilities are approaching the time when their distribution plants will be virtually free from interest and sinking fund charges on debenture debt. It is this condition, which, in the years to come, will enable Hydro utilities to make further reductions in the cost of energy, even below the low average cost now prevailing.

### No Diversion of Hydro Funds

Here I should like to utter a warning. The stability and security of this great enterprise rests upon maintaining inviolate our reserves and surplus funds. The proper use of these funds is set forth in The Power Commission Act.

Our municipal Hydro commissions are very sound financially; so sound in fact that hard-pressed councils which are unfamiliar with The Power Commission Act may see in Hydro surpluses a source of assistance and a relief from their financial difficulties and be tempted to try to appropriate these surplus funds. This is a matter of grave concern to the members of the Ontario Municipal Electric Association. The surpluses of the municipal Hydro utilities are the rightful property of the users of electricity and not of the taxpayers, and the municipalities have no powers under which they can confiscate surpluses for general purposes. This Commission will not permit any diversion of its own funds, or the funds of municipal Hydro commissions, for purposes other than those provided for by The Power Commission Act.

### The Future

Now let us consider for a few minutes the problems confronting Hydro in the immediate future. How do they differ from those of the past?

During the first two decades of the Hydro enterprise continuous rapid growth took place. The chief problem of the Commission during the first twenty years of its existence was that of providing sufficient power to meet the ever-pressing demand. The economic depression ended this period, and now the return of better times finds the Commission with ample supplies of power secured for some years ahead. One of the problems facing the Commission at the present time, therefore, is to make known to all Ontario's citizens the nature of the benefits which they can derive from making the fullest possible use of the low cost power which is now available.

Naturally, the question arises: "How much additional electricity can be profitably consumed by the present population?" We know that the per capita use of electricity in Ontario stands high, and that our people have been pioneers in electrical utilization. But in spite of this I am convinced that the people of Ontario are not making the fullest use of electric service, partly because they are not fully aware of its benefits.

I therefore ask you to further study the conditions in your particular util-

ity, and see if your customers are utilizing to the full the services you can give. Make a survey to determine the appliances in use by your domestic customers. Find out if the lighting equipment is up-to-date. Ascertain if your stores are as attractive as modern illumination can make them. Enquire if your industries are informed respecting the latest electric equipment available, and recommend that your street lighting be modernized to prevent accidents.

I ask you to do these things because it is our duty, your's and mine, not only to provide electric service at cost, but to give the best service to the greatest number at as low a cost as possible. I would even go as far as to say that we are not doing our jobs as well as we might if we do not do all we can to increase the use of electricity in our communities—rendering a conspicuous service and reducing its cost.

The Commission believes that planned effort is necessary to discharge this responsibility and during the past few years has devoted more attention to the promotion of the use of electricity in the home, on the farm, and in commercial institutions.

During the coming year the Commission plans to greatly enlarge its activities in the promotional field. Mr. M. J. McHenry has been appointed director of sales promotion. At the present time he is organizing a department responsible for advertising and promotional endeavour, and he is giving you a complete summary of his plans tomorrow afternoon, which I hope you will all hear. His department will form a co-ordinating medium, uniting the efforts of the municipal Hydro utilities, The Hydro-Electric Power Commission, and other branches of the electrical industry in the province. Only by such united effort can the maximum results be attained.

I think I have said enough to show you that the Commission realizes its responsibility for making the beneficial uses of electricity better known. I strongly urge and recommend that every Hydro municipality join in this co-operative effort to promote and extend the use of electric service.

Long ago it was stated by that eminent electrical engineer, Charles Steinmetz, that "Electricity is expensive because it is not widely used, and because it is not widely used it is expensive." In Ontario we have broken that vicious circle, and established a beneficial circle. In Ontario, "Electricity is inexpensive because it is widely used, and it is widely used because it is inexpensive." With your help it is going to be more widely used, and it is going to cost even less.

### Prepared for Peace or War

We are now living in a time of wars and rumours of wars. Rearmament and defence programs are the order of the day. Most of you will recall that the war of 1914-18 had not progressed very far before there came a demand for power, and still more power, for the manufacture of military supplies of all kinds, also that before long there was a serious power shortage. The Commission was caught unprepared to meet an unprecedented demand. You are now fully prepared

for any eventuality. You not only have sufficient reserves, which could be instantly diverted from secondary loads to important primary loads, but all told the Commission has over ten times the system capacity it had in 1914. Think what it means to be able to commence almost immediately to serve industries requiring an additional load of 200,000 horsepower or more. As a peaceful people we would much prefer to use all this power for constructive rather than destructive purposes, but, should the fates decide otherwise, we are prepared.

In a world in which established institutions and accepted values seem to be tottering, or losing their former significance, we do well to support those things which tend to stabilize and strengthen. Be critical if you will, but let your criticism be helpful and constructive. This enterprise of yours has been built up year by year to the splendid position it now occupies, by good, honest, Anglo-Saxon commonsense, co-operation and goodwill, and it is upon these same qualities that it must rely for its future success.

# Welding of Cast Iron

**By W. D. Walcott, Inspecting Engineer, H.E.P.C. Laboratories**

DUE to comparatively low production costs as well as to its great strength in compression, cast iron has in former years been extensively used in mechanical and electrical engineering practice. On account of its weakness in tension and shear, its place is being gradually taken by welded sections of mild steel. For these reasons, therefore, the welding of cast iron is limited chiefly to the repairing of castings which have failed in service; and to the filling up of blow holes, flaws and similar defects in iron castings.

The weldability of cast iron is affected to a large degree by its chemical composition, and a brief study of its chemistry and metallurgy will enable us to understand some of the difficulties encountered.

At the present time there are three varieties of cast iron which are commonly used:

A. Gray Cast Iron.

B. White Cast Iron.

C. Malleable Iron.

A. GRAY IRON

Gray iron has a total carbon content of from 3 to 4 per cent. This carbon consists of combined carbon such as that found in steel, and graphitic carbon which is composed of soft, flaky particles. The graphitic carbon is largely responsible for the comparative weakness of cast iron in tension and shear. The amount of combined carbon in gray iron ranges from .2 to .6 per cent., and the amount of gra-

*Fig. 1 — (100 ×) Cast Iron — not etched. White background metal, black markings are location of graphitic carbon.*

*Fig. 2—(100 ×) Cast Iron—etched. Background metal showing ferrite white and pearlite mottled. Black markings in white ferrite are graphitic carbon locations.*

phitic carbon from about 2.7 to 3.5 per cent.

B. WHITE IRON

White iron has a total carbon content of from 2.5 to 3.5 per cent. Practically all of this takes the form of combined carbon. The graphitic carbon varies from 0 to .5 per cent. The result of this combination is a hard brittle metal, difficult to machine and extremely difficult to weld. White iron, however, is seldom used in its original state for castings, but is used for making malleable cast iron.

C. MALLEABLE CAST IRON

Malleable cast iron is made by heat treating white cast iron so that the carbon content of the castings is uniformly distributed and is changed from combined carbon to free or temper carbon. The total carbon varies from 2 to 2.5 per cent., of which .2 to .3 per cent. is combined carbon, and 1.9 to 2.2 per cent. is graphitic carbon.

### METHODS OF WELDING

There are three methods which are commonly used in the welding of cast iron:

1. Acetylene Gas.
2. Carbon Arc.
3. Metallic Arc.

Each of these methods has special applications and advantages. We will now go into the details.

### ACETYLENE

This method consists of the use of the acetylene welding torch in conjunction with special cast iron or nonferrous filler rods made of Tobin and phosphor bronze, monel metal and nickel.

*(a) Welding with Cast Iron Filler Rod.*

When welding with a cast iron filler rod, the casting should be preheated, welded while hot, and then allowed to cool very slowly. The casting should

be carefully prepared by bevelling the edge of the fracture to an angle of about 45°. The bevelled surface should then be ground or brushed in order to remove scale, rust or dirt.

After heating the casting to a dull red, which is indicated by a temperature of about 1,100 deg. fahr., the sides and the bottom of the V should be melted by the torch to form a puddle about 1 inch long. The welding rod should be heated almost to the melting point and should then be inserted in the puddle with the tip of the rod under the surface. From time to time the rod should be taken out of the puddle and dipped into the flux. Any gas bubbles should be worked to the surface by manipulation of the rod and the torch using as much flux as is necessary. When this one-inch section has been built up, the operation is repeated on the next section until the whole weld is completed. Precautions should be taken to cool the casting as slowly as possible. Large castings should be cooled in a furnace and small castings should be cooled in sand, cement, asbestos fibre, or similar material.

*(b) Welding with Non-Ferrous Filler Rod.*

This method is considered by many authorities to be the most efficient method of welding cast iron, because the physical properties of the casting are not seriously affected due to the fact that the welding is done at a temperature below the melting point of cast iron. When this method is used, it is not necessary to preheat the casting. Tobin and phosphor bronze rods are the most commonly used for filler material but nickel and monel metal are sometimes used with good results. Bevelling of the edges is not absolutely necessary but it is advisable when the thickness of material to be welded is over 1/8 inch. The edges of the piece to be welded should be cleaned by grinding or brushing. A slightly oxidizing flame should be used with a suitable flux. At the start of the welding operation, a small area should be heated hot enough so that the metal from the rod will spread out in a thin layer over the parent metal in order to produce a foundation coating which acts as the bond between the parent metal and the deposited bronze. The strength of the weld will depend largely on the degree of fusion obtained by the deposition of metal in the first layer.

Tests have shown that properly made gas welds are as strong as the parent metal and are soft enough to be easily machined.

### Carbon Arc Welding

The use of the carbon arc in cast iron welding is limited chiefly to the filling of large blow holes, or in repairing similar defects. Before welding any of these cavities, they should be thoroughly chipped out to sound metal. The casting should then be placed so that the welding can be done in a downward position. The arc should be played on the bottom and sides of the hole in order to heat the metal to a red heat. The welding rod should then be fed into the cavity very gradually until it is filled and the arc played on the deposited metal so as to prevent rapid cooling. At the same time, the slag is floated to the top of

the weld and can be chipped off. The use of borax as a flux is helpful in floating off impurities such as scale and slag.

### METALLIC ARC WELDING

This process is by far the most difficult of the three due to the stresses resulting from expansion and contraction during welding. Up until four or five years ago electrodes of mild steel were the only electrodes used in the welding of cast iron. Since that time special cast iron electrodes of the shielded arc variety have been put on the market by several manufacturers. Some of these electrodes are of a steel base; others contain nickel or monel metal. These electrodes have brought about a great improvement in the quality of the welds, both from a standpoint of strength and machinability. There is a special technique to be observed and on its observance depends the quality of the weld obtained. For ordinary work the electrodes are usually not more than 1/8 of an inch in diameter and the current is limited to less than 100 amperes. Only short welds should be deposited, and then they should be allowed to cool before proceeding. By depositing small welds on various parts of the job one weld becomes cold while another weld is being deposited in some other location.

Peening is sometimes used as a method of relieving the strains set up during the welding of cast iron. While the metal is still hot, light blows are struck on the surface of the bead with a pneumatic air hammer. This causes the metal to stretch. Peening should be done on each bead immediately after it has been deposited.

Where welding is to be done with steel electrodes, mild steel rods are used with reversed polarity, making the electrode positive and the work negative. Thus the heat in the parent metal is reduced and the electrode is melted at a higher rate and is deposited faster than if ordinary polarity were used. In spite of this procedure a homogeneous joint can never be obtained as cast iron and steel will not mix intimately.

As the contraction of steel is approximately 3/16 to ¼ of an inch per foot in cooling from the molten state, and that of cast iron is ⅛ of an inch per foot, and as the casting is not melted in welding, the steel from the electrode tends to pull away from the iron. Means have, therefore, to be provided to prevent this separation. This is accomplished by what is popularly known as studding.

A number of steel studs are screwed into tapped holes and are cut off so as to project about ¼ of an inch above the surface. The filler material is then deposited around and above these studs, and it is made heavy enough to bind the two parts of the casting together. In addition, a crown or reinforcement is put on after the surface has been filled.

Great care must be taken in carrying out the welding technique. The work should be done in short runs of not more than two inches at a time using electrodes of small diameter, with the object of keeping the casting at such a temperature that it can be touched by the hand without inflicting a burn. The deposited metal should be peened until it cools, with a blunt caulking tool. The peening

stretches the metal while it is cooling and contracting and thus relieves the strains of contraction. As the weld metal is deposited, the steel studs become an integral part of the deposited mass and as they project above the surface of the iron at different angles they will offset the strains set up in the weld.

The efficiency of the weld will depend on two main factors:

1. The percentage of cementite or combined carbon in the cast iron.
2. The correctness of the technique used during welding.

In 1923 several cast iron test pieces were made by the acetylene method in the machine shop of one of the Commission's plants and were sent to the Laboratories for test. All the sections were double Veed at 90°; while some of the welds were studded and reinforced on the top, and others were not. Tests were made in bending and the highest efficiency obtained, compared with solid cast iron was 66 per cent., while the lowest was 33 per cent. The high result was obtained by studding and reinforcing; the low result by the omission of both.

### CONCLUSIONS

For many years the efficiency obtained in welding cast iron has been a subject of controversy in welding circles. There are some who claim that welds can be obtained which are as strong as the parent metal. There are others who claim that the efficiencies are quite low, in the neighbourhood of 45 to 50 per cent. It would seem that the truth lies somewhere halfway between these two opposite views, depending on the various conditions encountered.

As has been pointed out, the efficiency of a cast iron weld depends on several factors, the most important of which are the quality of the parent metal, the type of electrode used, and the technique employed. While a weld in cast iron will not be as strong as a weld made in mild steel, yet several important repairs have been made which have been quite satisfactory and which have been in service for many years.

Each of the three methods has applications for which it is specially suited. The oxy-acetylene gas method produces a weld which is strong and readily machinable. Its chief drawback is the difficulty and expense of preheating the parent metal.

The metallic arc provides a rapid and convenient method in which preheating is not necessary. The carbon arc provides a method of filling defects in castings.

Provided that the best method is chosen for doing any particular job and that the welding is properly done, a satisfactory job will doubtless be obtained.

# Unit Substations

By E. E. Forrest, Distribution Superintendent, Gary Heat, Light and Water Company

*(Presented to the Association of Municipal Electrical Utilities at Toronto, February 8, 1939.)*

LOAD growth in American cities almost always has an attendant geographical expansion that sooner or later exceeds the limitations of the original electrical distribution system, not only in capacity but likewise in voltage regulation. It is then that the distribution engineer is faced with making a major decision concerning the pattern that future distribution extensions will take. In Gary, Indiana, it was apparent in 1936 that such a decision had to be made. After a thorough study and analysis of the situation, the management of the Gary Heat, Light and Water Company authorized a major rehabilitation of the transmission and distribution system to take the form of a primary and secondary network utilizing unit type substations. In addition to numerous operating advantages, this ultra modern type of electrical distribution system held new investment per kv-a. to a minimum.

Gary has enjoyed a phenomenal growth from its founding in 1906 to its present population of 115,000. Up to the latter part of 1937 electrical service was supplied at 25 cycles. The main part of the city was supplied from two substations through radial feeders. The feeders, equipped with induction voltage regulators, had by continuous extension, become very long resulting in poor voltage conditions in addition to overloading (See Fig. 1).

The program to correct these conditions and provide for meeting a future growth is now 25 per cent. completed. It consists of changing over to 60 cycles and reconnecting the old 4.33-kv. feeders into a primary grid (See Fig. 2), installing unit type substations (factory-built and assembled switchboard and transformer units) as supply points for the network and as supply points for a new underground secondary network for the commercial area.

### CUTS COSTS—INCREASES REVENUE

A primary network, fed by unit type substations, has many advantages over the conventional radial system in the distribution of electric energy. Some of the improvements to be effected in the new Gary distribution system are as follows:

(*a*) *Operating Expenses*

1. Reduction of distribution and transmission losses.

2. Reduction in operating force.

(*b*) *Investment Cost*

1. Reduction of substation equipment and installation costs.

2. Saves replacement costs of originally installed small copper to increase capacity of feeders.

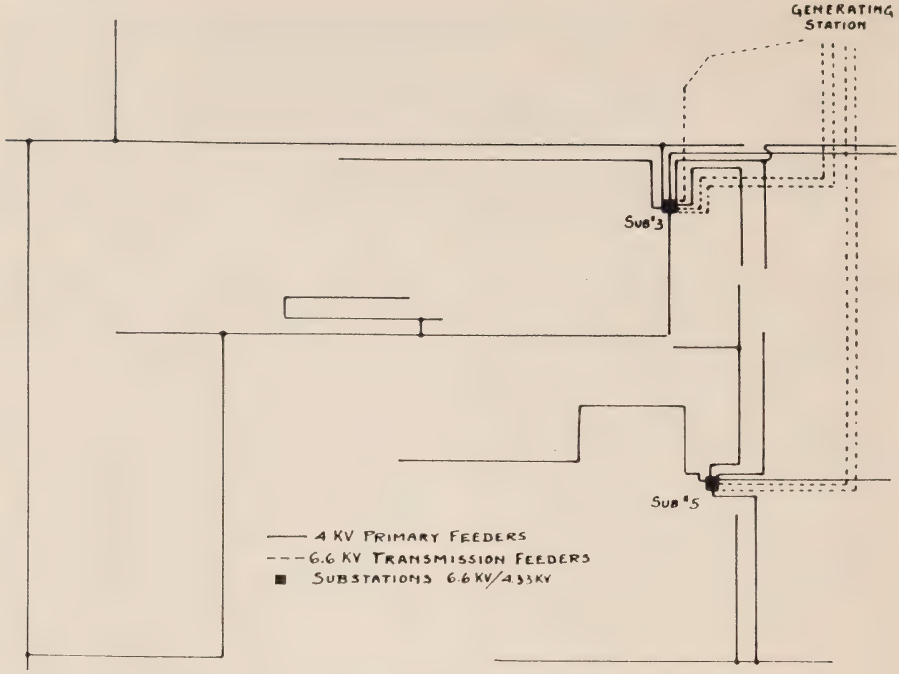



*Fig. 1—Radial distribution system, 25 cycle.*

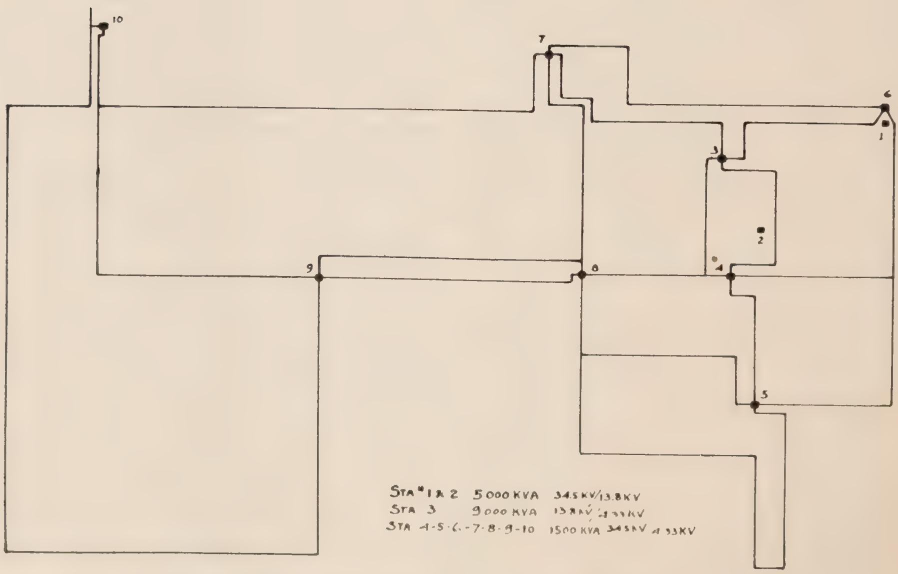



*Fig. 2—Single line diagram of 4.33 kv. network.*

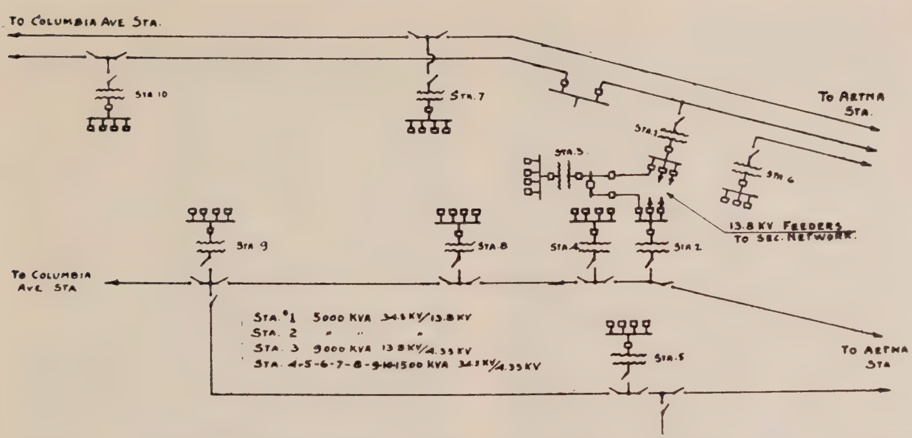



*Fig. 3—34.5 kv. transmission lines, 60 cycle and unit substation arrangement.*

3. Reduction of land investment for substation sites.

(*c*) *Revenue*

1. Prevent revenue loss due to low voltage in outlying sections of load areas.

2. Prevent revenue losses due to outages caused by substation and transmission faults.

3. Prevent revenue losses due to extended outages caused by radial primary feeder faults.

*(d) Service*

1. Improve voltage regulation.

2. Provide a higher standard of continuity.

### FACILITATES FREQUENCY CHANGE

The entire electric supply to the city is now being changed from 25 to 60 cycles. The unit substations to supply the new primary and secondary networks, as shown in Fig. 3, will be operated on 60 cycles, and customers' equipment is being converted for 60 cycle operation at the present time. Several 34.5-kv. transmission lines pass through the city and others will be added as the new 60 cycle load develops. The unit substations feeding the primary network tap these 34.5-kv. transmission lines through air break switches. Lightning arresters are mounted on top of the transformer of this unit and voltage regulation is provided by tap changing equipment mounted integral with the transformer unit.

The fundamental principle underlying the supply to the primary network is to provide a number of small unit substations supplied from divers sources, and interconnected by short 4.33 kv. feeders as contrasted to the conventional system where a large amount of substation capacity is concentrated in one or more points supplying a large number of radial feeders. Consequently the $I^2R$ losses in the 4.33 kv. primary network will be less than one-fourth the losses in a radial system for the same load and the same load area, as the power is transmitted to several points of the load area at 34.5 kv. and for the further reason that practically all dis-

*Fig. 4—Unit substation located on a vacant lot in a commercial area.*

tribution feeders are fed from both ends.

VOLTAGE INCREASED WITHOUT COPPER INVESTMENT

The outlying sections of radial feeders are very often inadequate and in need of replacement with larger copper to carry the load. By making them part of a primary network the capacity of the line is nearly doubled, thereby avoiding large increases in investment for feeder improvements.

We have selected the 1,500-kv-a. self-cooled transformer network unit as the most practical size for our requirements. Each unit has four outgoing feeder switch positions, each equipped with overcurrent protection. Overcurrent and reverse power relays are also provided on the 4.33-kv. oil circuit breaker between the transformer and the 4.33-kv. bus. This 1,500-kv-a. unit has a continuous forced-air-cooled rating of 2,000-kv-a., and an emergency overload capacity

*Fig. 5—Unit substation located adjacent to a first class residential section.*

for short periods of 2,800-kv-a. These network units are very compact and occupy a small amount of space, and can very easily be located on small areas of vacant property in commercial sections (See Fig. 4); in other cases they are located adjacent to first class residential sections and partially concealed by landscaping, as shown in Fig. 5.

Due to the fact that these units are easily movable and may be set up and placed in temporary operation in a few hours, they are particularly valuable in connection with our frequency conversion program.

EMBODIES FUTURE FLEXIBILITY

In the design of a radial system it is of prime importance to properly forecast where and in what direction load growth will develop, and often these predictions prove to be erroneous. In the design of a network system this element of doubt is removed by the fact that any part of a primary network can be expanded to

take care of load growth without alteration of previously installed portions of the primary network system. If large loads should shift and it should become necessary to remove a unit substation, practically everything may be salvaged and reinstalled at another location at a nominal expense.

For general distribution purposes the unit type substations may be located in proximity to transmission lines on the fringe of the load areas where sites can be obtained at a nominal cost, and the interconnecting feeders will route through the heavily loaded areas.

### Power Factor Less Bothersome

In long radial feeders the voltage may be boosted by regulating equipment to a value which is limited by the maximum voltage permissible for customers located near the substation, consequently voltage regulation in the outlying sections of the load area is very poor during peak load periods and results in unsatisfactory service and loss of revenue. This inherent weakness of the radial system, which in our case is becoming very critical at the present time due to low power factor load growth, is solved by the primary network due to the fact that the distribution feeders are supplied at both ends and at the same time generally shortened to form the ties between substations. Consequently the voltage in all parts of the load areas is brought up to standard, thereby improving service and increasing revenue.

### Reduces Interruptions

The overhead primary network further avoids revenue loss due to the service interruptions so prevalent to a radial system, especially those caused by transmission failure or substation faults. When service is interrupted due to a fault in a network feeder between two substations, service may be restored as soon as the fault is cleared, thereby avoiding extended interruptions while line repairs are being made. In a primary network, a substation and transmission line may be taken out of service at any time for inspection and maintenance without interruption of the service; this also facilitates cleaning and repairing with a maximum amount of safety, and at the convenience of the maintenance crews.

### Costs

The conventional type of fully automatic radial substation equipped with induction feeder regulators and truck type switchboard supplying a radial system must provide reserve capacity for emergency service. It must also be located near the centre of the load area to efficiently serve the system, consequently property values are usually very high and facilities for incoming and outgoing circuits are usually most difficult and expensive.

The average cost of a conventional radial substation in accordance with our past practice, is $42.00 on a firm capacity basis of 2,800 kv-a. Of this figure real estate and improvement expense and induction voltage regulators account for approximately 33 per cent. The unit type substation *as applied to a radial distribution system* is considerably cheaper than the conventional type of substation due to the elimination of induction feeder regu-

lators which are replaced in this type of construction by tap changing equipment mounted integral with the transformer unit and elimination of building expense. Consequently two 1,500-2,000-kv-a. unit type substations placed on the same lot with an emergency rating of 2,800 kv-a. could be installed to supply a radial system at a cost of $83,400 or $30 per kv-a., thereby showing a reduction of investment costs of $12.00 per kv-a. and producing a substation layout which is more flexible and more reliable to operate.

The unit type substation *as applied to a primary network* results in a much greater saving. The following tabulation shows the cost of a typical unit substation installation:

required. The saving in cost per kv-a. of installed substation capacity increases rapidly as additional unit type substations are added to the primary network system. In the case of a three-substation network the system could be safely loaded to 5,600 kv-a. at a cost of approximately $21.00 per kv-a. This decrease in unit cost is due to the fact that the network having two 1,500-2,000-kv-a. unit substations for supply would have an emergency rating of 2,800 kv-a., while the network having a three-substation source of supply would have an emergency rating of 5,600 kv-a.; this being based on the assumption that one substation is out of service and the load is absorbed by remaining substations.

Even if unit substations cost about

| | |
|---|---|
| 1,500-2,000 kv-a. Unit Substation | $32,500 |
| Foundation, Steel Tower and 34.5-kv. switch | 1,750 |
| 4.33-kv. Underground laterals | 1,850 |
| Labor to install unit | 600 |
| Land, Fence and Miscellaneous Equipment | 2,500 |
| Landscaping and Sidewalks where necessary | 800 |
| | $40,000 |

A primary network supplied by two such unit type substations equipped with tap changing equipment, with provision for four 4.33-kv. feeders, each unit substation having a self-cooled capacity of 1,500-kv-a., a forced-air-cooled capacity of 2,000 kv-a. and a short time emergency capacity of 2,800 kv-a., could be safely loaded to 2,800 kv-a. in an emergency. On this basis the two primary network units could be installed for $28.50 per kv-a. which is slightly less than the previous cost because of lower cost real estate permitted by the small lots

the same installed at one location or two, there would still be substantial savings in the 4.33-kv. distribution circuits, particularly since no substantial cost is involved in getting 34.5-kv. supply to the different locations.

In Fig. 6 is shown the primary network as it stands today. The first step was to install station No. 4 in the fall of 1937. For the time this was operated as a simple radial substation. Likewise station No. 9 was installed in March, 1938, and operated as a radial substation and connected to the same 34.5 kv-a. circuit as was station

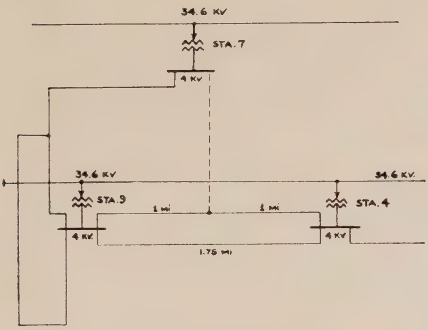



*Fig. 6—Primary network as at present.*

No. 4. This, of course, did involve some interruption to service due to faults on the 34.5 kv. circuit. This was acceptable in view of the small load carried and the temporary nature of the arrangement. Later station No. 7 was installed and tied in on the 4-kv. side with station No. 9. This gave duplicate supply to the primary network nucleus inasmuch as station 7 was connected to a different 34.5-kv. circuit. In August, 1938, the 4-kv. circuits were interconnected between station No. 4 and station No. 9 and station No. 7 as shown in the illustration.

The load up to the present is about 2,500 kv-a. and is adequately provided for even if stations Nos. 9 and 4 are out at the same time due to a 34.5-kv. fault. Next spring station No. 5 will be installed and supplied from a third 34.5-kv. circuit and interconnected with station No. 4 on the 4-kv. side. The actual installation cost of these three units complete amounts to $119,800. The 4-kv. tie lines to form the network cost $8,300.

In view of the change from 25 to 60 cycles the primary network would inherently provide a 60 cycle source for cutover at a much lower cost than if a large radial substation had been provided at one location due principally to the running of new feeders and an extensive replacement of small copper. No estimate has been made to determine what this would have been if we had installed the larger radial station but from what we know of the conditions this would have exceeded the $8,300 several times over.

Futhermore, the unit substation being portable and not installed until the time it is required made it easy to change our original plan to conform more closely with actual conditions and thereby substantial expenditures being made in order to adapt an installation prematurely made to suit these anticipated changes in circumstances. In addition the portability of these units permitted their use at temporary locations to facilitate changeover.

Resistance compensation only is used on the regulating equipment and is adjusted to hold equal voltages at the substations. The performance of the regulating equipment has been successful.

### PROTECTION SCHEME

The relay equipment consists of reverse power relays on the transformer breakers and overload relays on the feeder breakers. Their settings were determined by a short circuit and relay study and so far have given correct operation on the few faults that have developed. Some of the branches are fused.

Fig. 7 shows a one line diagram of the ultimate 4.33-kv. primary network system as interconnected with the

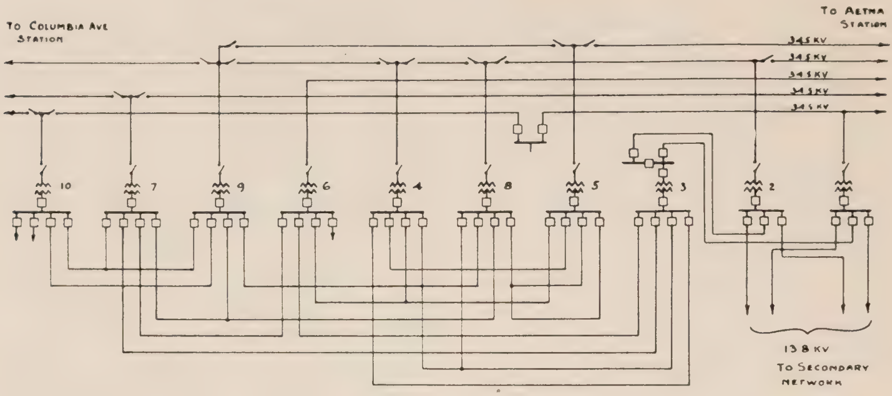



*Fig. 7—The ultimate 4.33 kv. primary network.*

unit substations supplying the secondary network. Station No. 3, as shown on this diagram, is an existing 25-cycle radial station and is equipped with two 5,000-kv-a. transformer banks, 6,600/2,300 to 4,000 volts wye, 25-cycle. The firm capacity rating of this station is 5,000 kv-a.

As the 25-cycle load is converted to 60-cycle operation it will be transferred to the 60-cycle primary network and carried on the unit type substations installed in this load area, and ultimately station No. 3 will be completely unloaded and will be rebuilt for 60-cycle operation, and then become a unit in the 60-cycle primary network system.

It will be noted that a 13.8-kv. tie line between stations No. 1 and No. 2 will tie through a section of bus in station No. 3. One of the 5,000-kv-a., 25-cycle transformer banks, which consists of three 1,667-kv-a. transformers, will be fed from the 13.8-kv., 60-cycle system by this tie line. Since the frequency is increased 2.4 times it will be possible to operate these transformers on 60 cycles at double their normal 25-cycle voltage, and by changing the secondary coils within each transformer from a series to a parallel connection, the ratio of transformation will be reduced to one-half the 25-cycle ratio to compensate for the increase in primary voltage and thus obtain 2,400 volts secondary. This alteration in transformer connections will be made at a nominal expense, and the 60-cycle rating of this bank of transformer will become 9,000 kv-a. Theoretically the kv-a. ratings would increase in the same proportion as the applied primary voltage, however, the losses are increased when operated on 60 cycles, which prevents the capacity from changing in the same ratio as the applied primary voltage. Station No. 3 will, therefore, become an interconnection between the 13.8-kv. subtransmission system which supplied the existing secondary network and the primary network, capable of feeding energy in either direction. With this interconnection the reserve capacity available in stations No. 1 and No. 2, which supply the secondary network, will be utilized by feeding

through this substation into the 4.33-kv. primary network. In case of an emergency this station may also take energy from the 4.33-kv. primary network and transform to 13.8-kv. to feed the secondary network. This arrangement provides a reserve of substation capacity for load growth, which is very rapid at the present time due to air conditioning and high intensity lighting.

The pumping equipment of the city water system is also supplied from station No. 3. This interconnection between the 13.8-kv. subtransmission system and the 4.33-kv. primary network system provides six sources of supply to guarantee continuity of service to this pumping station.

### SUPERVISORY CONTROL FOR OPERATIONS

Each of the unit type substations, namely stations Nos. 4, 5, 6, 7, 8, 9 and 10, which supply the 4.33-kv. primary network, are fully automatic, and have three reclosures at 15, 30 and 75 second intervals, after which they lock open. Each of these stations is equipped with 5-point supervisory control equipment with the master control located at station No. 3, which places all oil circuit breakers under the definite control of the operators in this station. This control is so arranged that in case of a lockout in any substation the automatic reclosing mechanism may be reset by an operation of the supervisory equipment from the master control board. Substations Nos. 1 and 2 supplying the secondary network, are also equipped with supervisory control, likewise will be controlled from the master control located in substation No. 3.

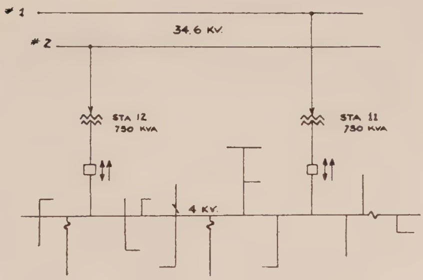



*Fig. 8—The nucleus of a primary network.*

Substation No. 3 will be the only attended substation in the system. The operators in this substation will have complete control of the 4.33-kv. network and the secondary network.

### FUSES USED TO PROTECT PORTIONS OF THE GRID

In Fig. 8 is illustrated the nucleus of a primary network inaugurated nearly 6 months ago in a suburban area utilizing 750-kv-a. units with a single circuit breaker. The arrangement is quite similar to that introduced by the Philadelphia Electric Company (See *Electric Light and Power,* Sept., 1937) in that most faults on the principal part of the 4-kv. system are depended upon to burn themselves clear. However, some of the primary branches passing through bad tree conditions are fused. Faults on the transmission circuits or in the transformers are cleared by reverse power relays. Additional overload relays having long time settings are also provided just in case some faults fail to clear themselves.

So far—there have been numerous instances of branch fuses blowing but no instance of faults on the unfused portion either burning down conductors or opening the circuit breakers.

So what faults as have occurred on the unfused portions have been self clearing but just how many cannot be determined.

The 34.5-kv. circuits are on the same tower structure and for that reason have permitted two instances of faults involving both lines and consequently interrupting both units for a minute or so until one good line could be energized. One fault occurred involving only one circuit and was cleared promptly and correctly by the reverse power relay without interruption of supply to the network.

The maximum load in this district occurred in July and amounted to approximately 600 kv-a. The compensation is obtained entirely by the resistance elements. They were originally adjusted to give approximately equal load division but due to the fact there is a substantial commercial load near station No. 11, the voltage at station No. 12 was too high. Equal load division was not essential since the capacity was determined by the condition of one unit being out of service and the remaining unit carrying the load safely so the compensation was changed to give equal voltages at both stations. Under this condition station No. 11 carried 56 per cent. of the total load. The regulating equipments have performed successfully.

The two stations were installed at a cost of $21,000 each with an expenditure of about $4,000 required to build the 4-kv. tie. The expectation is to carry an ultimate load of 900 kv-a. on this combination before re-enforcement is added. The decision to form this network nucleus was based largely on the fact that duplicate facilities were desirable, and if they were operated as simple radial substations the tie line and load limitations would still be necessary because one substation would still be expected to carry the entire load and it was furthermore desirable to obtain some operating experience with this combination. At the same time a voltage improvement is made due both to the supply at two locations instead of one and the interconnection giving the benefit of diversity between loads. It is the expectation that two 34.5 kv. circuits that are not on the same structure will be available in the near future so that the full benefit of duplication will be obtained instead of partial as at present.

### Secondary Network

The secondary network is of the conventional type as shown in Fig. 9, and covers an area of .0735 square miles with an initial load of 4,000 kv-a., and is designed to expand to cover an area of .55 square miles with an ultimate load of 12,000 kv-a. All calculations were based on a 3 per cent maximum voltage drop under normal conditions. The secondary grid consists of 2—250,000 cir. mils, single-conductor, non-leaded cables in parallel (per phase) arranged in two groups, each consisting of an insulated neutral and three line cables of the same size. The groups are isolated by pulling each group of four cables into a four inch fibre duct laid in concrete. In locations where load conditions are such that more grid capacity is required, additional groups of three line conductors and neutral are added in par-

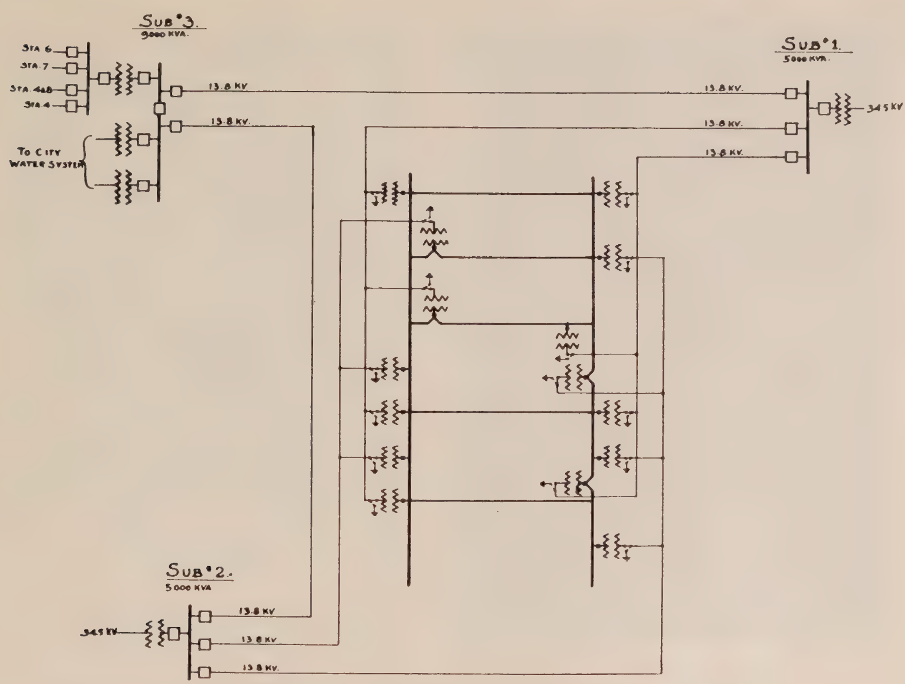



*Fig. 9—13.8 subtransmission system for secondary network, 60 cycle.*

allel to existing groups. The 250,000 cir. mils cable is insulated with 6/64-in. performite rubber compound, one layer rubberized tape and single braid. Cable was purchased with four conductors wrapped in parallel on reels. Each conductor has a different coloured tape to facilitate rapid connection, and thereby reduce installation costs.

On the initial installation 15—500, kv-a., 3-phase, 13.8-kv./216-125 volt transformer units were installed in vaults in the street or buildings with a 1,600 ampere network protector, and a high tension disconnecting and grounding switch mounted on each transformer. The high tension switch and transformer units are filled with a non-inflammable liquid to avoid fire hazard. The high tension switches are designed to break exciting current so that the transformers may be removed from service without de-energizing the 13.8-kv. feeders. The connection from the network protector to the secondary grid consists of three 500,000 cir. mils non-leaded cables in parallel per leg. Where convenient the grid conductors run directly to and from the terminals of the network protectors.

The secondary grid is connected through multi-tap connection devices in all service holes to provide for service connections as shown in Fig. 10, and a ring bus as shown in Fig. 11 is installed in all manholes at junction points to provide two, three or four-way connections of grid conductors

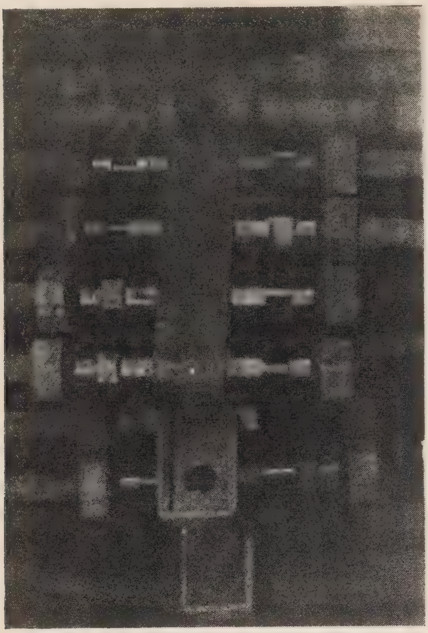


*Fig. 10—Multi-tap connection device in service hole.*

and facilitate connections of supply cables from the transformer units. Five hundred thousand circular mil non-leaded cable was used in the construction of the ring bus by connecting through multi-tap connection devices to close the ring and provide for connection of all cables. The bus and multi-taps were mounted on strap copper supporting structure which was used for the neutral connection through the manholes as shown in Fig. 11. These buses and supporting structures were standardized and entirely constructed in the shop and assembled in the manhole, thereby reducing field and overall construction costs appreciably.

The secondary network transformers are supplied by four 3-conductor, No. 0000 paper insulated, type H,

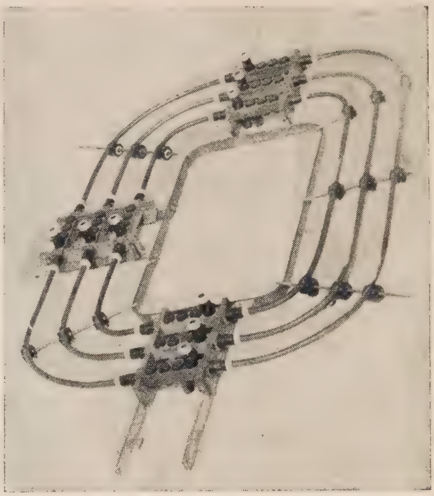


*Fig. 11—Ring bus as installed in all manholes.*

shielded lead-covered cables, and the system is designed for a two-circuit outage, i.e., one circuit held out of service for workmen and one circuit out due to fault without overloading remaining cables or transformers.

## Hydro Engineers Honoured

Two members of the Commission's staff have been elected to the presidency of engineering organizations, for the year 1939, during this month. W. P. Dobson, Chief Testing Engineer of the Commission, was elected President of the Association of Professional Engineers of Ontario, and H. C. Don Carlos, Chief Operating Engineer, President of the Engineers' Club of Toronto. The Bulletin extends to them both congratulations and best wishes during their terms of office.

# The Winter Convention

THAT The Hydro-Electric Power Commission of Ontario is planning to extend its activities towards obtaining greater increase in loads, was the message to the winter convention of the Ontario Municipal Electric Association and the Association of Municipal Electrical Utilities. At the opening luncheon, Dr. T. H. Hogg, Hydro Chairman, addressed the delegates introducing the subject to be considered that afternoon, being a review of Hydro operations for 1938 and forecast for 1939. At the convention session following, engineers of the Municipal Engineering department elaborated on the different systems operated by the Commission. The second afternoon was devoted to discussion of plans worked out for sales promotion. The addresses on this phase of the Commission's work are covered in this and the following issues of *The Bulletin* as also A.M.E.U. papers and reports.

The 1939 Summer Convention of the two associations will be held at the Chateau Laurier, Ottawa, on July 4th and 5th.

* * * *

## O. M. E. A.

The election of Officers of the Ontario Municipal Electric Association for the year 1939 gave the following results:—

*Honorary President* — Dr. T. H. Hogg, Chairman, H.E.P.C. of Ontario, Toronto.

*Honorary Vice-Presidents*—F. C. Elliott, Ingersoll; T. A. McFarland, London; David Hurrie, Midland and Joseph Gibbons, Toronto.

*President* — Gordon S. Matthews, Peterborough.

*Vice-Presidents*—

*District No. 1*—W. R. Strike, Bowmanville.

*District No. 2*—John Kalte, Hanover.

*District No. 3*—J. R. Irwin, Fort William.

*District No. 4*—K. A. Christie, K.C., Toronto.

*District No. 5*—Dr. W. J. Chapman, St. Catharines.

*District No. 6*—E. L. Box, Seaforth.

*District No. 7* — James Kirby, Strathroy.

*District No. 8*—G. N. Galloway, Sarnia.

*District Directors*—

*District No. 1* — James Halliday, Kingston and W. D. Boddy, Oshawa.

*District No. 2*—R. D. Boyse, Alliston and W. V. Brown, Meaford.

*District No. 3*—Grenville Walsh, Port Arthur and S. Ashton, Port Arthur.

*District No. 4*—E. W. McCulloch, Brampton and E. W. Grant, New Toronto.

*District No. 5*—Keith Macleod, Stamford Centre and Dr. J. S. Boyd, Simcoe.

*District No. 6*—(2 to be elected).

*District No. 7*—J. B. Hay, London, and B. N. Downing, Beachville.

*District No. 8*—Garnet Edwards,

Windsor and F. A. Fitzgerald, Petrolia.

* * * *

## A. M. E. U.

Officers of the Association of Municipal Electrical Utilities elected for the year 1939 are as follows:—

*President*—G. E. Chase, Bowmanville.

*Vice-President* — A. B. Manson, Stratford.

*Secretary* — S. R. A. Clement, H.E.P.C. of Ontario, Toronto.

*Treasurer*—S. E. Preston, H.E.P.C. of Ontario, Toronto.

*Directors (from the membership at large)*—W. R. Catton, Brantford; J. W. Peart, St. Thomas; P. B. Yates, St. Catharines.

*District Directors*—

*Niagara District*—H. R. Hatcher, Galt.

*Central District*—O. H. Scott, Belleville.

*Georgian Bay District*—C. E. Brown, Meaford.

*Eastern District*—A. L. Farquharson, Brockville.

*Northern District*—R. B. Chandler, Port Arthur.

The standing committees for the year were drafted at a meeting of the Executive Committee held during the convention as follows:

*Papers Committee*—J. W. Peart, St. Thomas, Chairman; E. V. Buchanan, London; A. W. Bradt, Hamilton; C. E. Schwenger, Toronto; R. M. Love, Canadian General Electric Co., Toronto; C. W. Hookway, Canadian Westinghouse Co., Toronto; J. J. Jeffery and M. J. McHenry, H.E.P.C. of Ontario, Toronto.

*Convention Committee*—A. B. Manson, Stratford, Chairman; S. W. Canniff, Ottawa; J. E. B. Phelps, Sarnia; O. H. Scott, Belleville; F. Mahoney, Canadian General Electric Co., Toronto; E. G. McCracken, Sangamo Electric Co., Toronto; W. R. Greenshields, Canada Wire and Cable Co., Toronto; G. F. Drewry and B. Mulholland, H.E.P.C. of Ontario, Toronto.

*Regulations and Standards Committee*—C. E. Brown, Meaford, Chairman; S. W. Canniff, Ottawa; M W. Rogers, Carleton Place; F. D. Hubbell, Windsor; F. W. Peasnell, Toronto; R. L. Dobbin, Peterborough; J. Eckersley, Toronto; A. G. Hall, H.E.P.C. of Ontario, Toronto.

*Committee on Accident Prevention and Health Promotion*—P. E. Yates, St. Catharines, Chairman; J. E. B. Phelps, Sarnia; C. E. Schwenger, Toronto; J. W. Peart, St. Thomas; R. Harrison, Scarborough Twp.; V. A. McKillop, London; F. D. Hubbell, Windsor; R. L. Dobbin, Peterborough; A. B. Manson, Stratford; R. J. Smith, Perth; B. Mulholland, V. A. Beacock and Wills Maclachlan, H.E.P.C. of Ontario, Toronto.

*Merchandising Committee* — O. H. Scott, Belleville, Chairman; R. W. Turner, Hamilton; A. W. J. Stewart, Toronto; F. S. Rhoads, Windsor; E. Parsons, Sarnia; R. S. Reynolds, Chatham; F. Wilkinson, London; N. Robinson, Stratford; O. C. Thal, Kitchener; H. R. Hatcher, Galt; S. W. Canniff, Ottawa; M. J. McHenry, G. J. Mickler and W. C. Dymond, H.E.P.C. of Ontario, Toronto.

*Rates Committee* — W. R. Catton, Brantford, Chairman; A. B. Manson,

Stratford; G. E. Chase, Bowmanville; P. B. Yates, St. Catharines; O. H. Scott, Belleville; O. M. Perry, Windsor; R. S. Reynolds, Chatham; T. R. C. Flint and F. W. Peasnell, Toronto; R. B. Chandler, Port Arthur; J. J. Jeffery, G. F. Drewry and S. R. A. Clement, H.E.P.C. of Ontario, Toronto.

*Committee on Accounting and Office Administration*—H. R. Hatcher, Galt, Chairman; George Appleton, Toronto, Vice-Chairman; T. W. Houtby, Welland; A. B. Manson, Stratford; J. A. Hammond, Hamilton; W. E. Wallace, Windsor; M. A. Gough, East York Twp.; J. W. Bayliss, Niagara Falls; C. W. Eastwood, London; P. E. Battram, Sarnia; R. S. King, Midland; W. M. Salter, Barrie; R. C. Parker, Penetanguishene; M. W. Rogers, Carleton Place; H. Clegg, Peterborough; A. D. Nelson, Kingston; A. L. Farquharson, Brockville; O. H. Scott, Belleville; Thos. Merritt, Ottawa; R. H. Martindale, Sudbury; R. M. Bond, H.E.P.C. of Ontario, Toronto.

*Auditors*—H. P. L. Hillman, Toronto and W. G. Pierdon, H.E.P.C. of Ontario, Toronto.

* * * *

## Report of the Committee on Accounting and Office Administration

The Committee held three meetings during the year for the purpose of transacting the general business of the Committee. These meetings were well attended and considerable interest was in evidence in respect to the affairs of the Committee.

In addition the following special meetings were called under the direction of the Committee:

(1) A Breakfast Meeting on 9th February, 1938, at which some 78 representatives of the Municipalities and Office Equipment Companies were present. The meeting took the form of a round table discussion on the general theme of "Consumers' Relations." A talking picture was also presented by the Dictaphone Company to illustrate the use of the Dictaphone in business.

(2) A Breakfast Meeting held at Bigwin Inn on July 6, 1938, at which forty representatives were present. This meeting was addressed by Mr. Austin H. Carr, C.A., Auditor, Canadian Chartered Accountant on the subject "Progress in Accounting".

(3) A Regional Meeting was held at Brockville on 21st September, 1938, at which forty representatives from the Eastern section were present along with representatives of Equipment Manufacturing Companies. This meeting was held for the purpose of giving those in attendance an opportunity of discussing accounting methods and viewing up-to-date office equipment. The Brockville Public Utilities Commission very kindly acted as hosts at luncheon at the Revere Hotel.

(4) A Regional Meeting was held at the Hotel London, London, Ontario, on October 26, 1938, at which some eighty-six representatives of

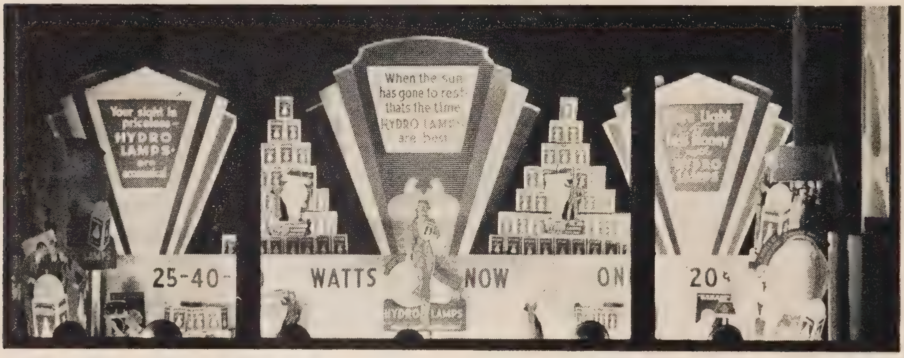
*(Continued on page 64)*

# Hydro Lamp Window Dressing Contest Awards

## Class 2

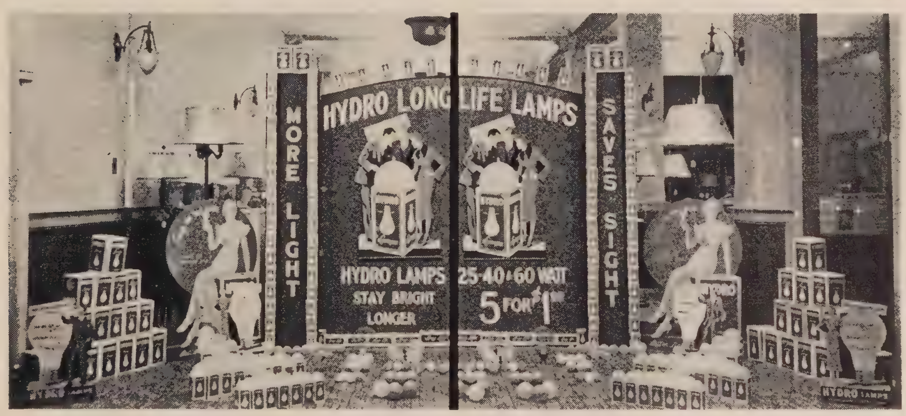
The Class 2 awards in the 1938 Annual Hydro Lamp Window Dressing Contest shown herewith are from the Hydro Shops located in the smaller Cities. As in the past, these displays are equal in excellence of arrangement and interest to Class 1 entries. They certainly helped to sell Hydro Long Life Lamps.

*Opposite—Second Prize, Class 2, Chatham Public Utilities Commission.*

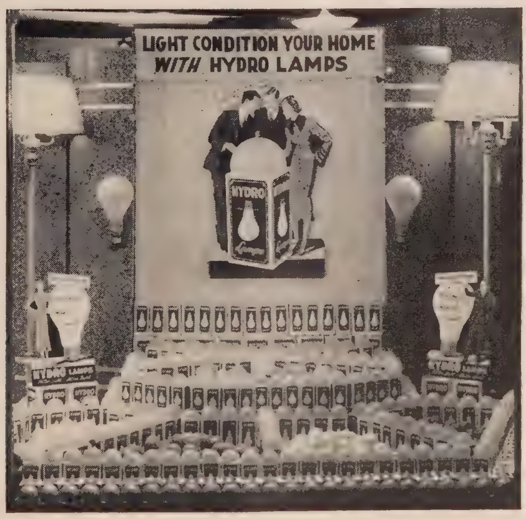



*Tie First Prize, Class 2, Kitchener Public Utilities Commission.*


*Tie First Prize, Class 2, Belleville Public Utilities Commission.*


*Above — Tie Third Prize, Class 2, Stratford Public Utilities Commission.*




*Right—Tie Third Prize, Class 2, Sarnia Hydro-Electric Commission.*

*(Continued from page 61)*
Municipalities in the Western section and Office Equipment Companies were present. This meeting was also held for the purpose of giving the Municipal representatives the opportunity of discussing accounting methods and seeing up-to-date office equipment demonstrated.

Both of the Regional Meetings were addressed by Municipal representatives and members of the staff of the Municipal Accounting department in Toronto.

During the year the Committee has seen fit to set up sub-committees as follows:—

(1) *Customer Relations and Publicity*—under the Chairmanship of Mr. W. E. Wallace, Windsor.

(2) *Collections and Co-operative Methods*—under the Chairmanship of Mr. M. A. Gough, East York Township.

(3) *Legislation*—under the Chairmanship of Mr. W. G. Henderson, Cobourg.

(4) *Committee on Revision of Standard Accounting Manual*—under the Chairmanship of Mr. George Appleton, Toronto.

These sub-committees will all report to the next meeting of the Standing Committee to be held during the Winter Convention, 1939.

The Committee has adopted the policy of holding at least two Regional Meetings per annum for the purpose of giving opportunity to the Municipalities interested to discuss accounting methods and procedure and to provide the means of displaying up-to-date office equipment from time to time. It is felt that in this way the Committee will reach a larger number of those directly concerned in matters of accounting than at the regular Convention meetings.

The feasibility of introducing a plan to provide facilities for Accounting Education to members of the staffs of the Municipalities is being considered. It is thought that such a plan if put into operation would not only tend to make the employees more efficient in their work but would also give them a higher standing in respect to general accounting information and would enable them to improve their positions as the occasion was presented. It is hoped that this plan can be worked out with the cooperation of the Department of Education of the Province of Ontario and the Employees Relations Department —H.E.P.C.

The Committee has also established a clearing house for the filing of information for the municipalities in respect to used office equipment. This will no doubt prove to be quite useful to the Municipalities.

(Sgd.) W. G. HENDERSON,
*Chairman.*

* * * *

## Report of the Committee on Accident Prevention and Health Promotion

During the past year the members of this committee have had no meetings but each member of the committee has been circularized, asking

for suggestions for the continued activities of the committee. On the basis of reports received, the committee would make the following suggestions:

All members of the Executive of the Electrical Employers Association who are also members of the A.M.E.U. should be members of the Committee on Accident Prevention and Health Promotion. The work of this committee ties in so closely with the accident prevention work of the Electrical Employers Association that the membership should be identical insofar as this is possible for our Association.

As Chairman of the committee and a member of the Executive of the Electrical Employers Association, arrangements have been made again this year for a dinner meeting of all those members of the Association who are actively interested in accident prevention work. This continues the policy of holding these dinner meetings established during the last few years. It is the desire of your committee to secure the wishes of the Association regarding these meetings.

The committee is pleased to report that the successful work of the Electrical Employers Association has been recognized by the Workmen's Compensation Board. This recognition consists of the approval by the Board of the budget requested by the Executive of the Electrical Employers Association, and complies with the request of the Association that the Electrical Employers Association be allowed to continue its work independently and not as a branch of the Canadian Manufacturers' Association, which had been suggested.

From reports received we would suggest that greater stress be now placed on the prevention of accidents due to automotive traffic on the highways. The employees of the electrical system working on the borders of the highways should be more carefully protected. Greater care should also be exercised in the transportation of the line crews from place to place. This type of accident is increasing and should be given greater attention.

One suggestion of the committee which might be of great value is that an effort should be made in the smaller municipalities to form groups of citizens who might be trained in artificial respiration. In so many of the smaller municipalities where the electrical staff is too small to successfully carry out the work required in case of electric shock, drowning or gas poisoning, it should be possible to call on these citizens for immediate help in case of accident. Where the electrical staff is small, composed possibly of two or three men, or less, there may be little danger of accidents due to electrical work. But there is always the possibility that the electrical staff, augmented by citizens, might reduce the annual loss of the youth of the province due to drowning accidents. It is the suggestion of your committee that if the Association approves, that more attention be given to this phase of accident prevention work.

P. B. YATES,
Chairman.

* * * *

# Report of the Merchandising Committee

The Merchandising Committee held two meetings in Toronto during the year to consider various problems in connection with Sales Promotion Campaigns which have been conducted in the past, and which it is contemplated to conduct in the Hydro municipalities in the future, also to obtain new ideas from Hydro municipalities on how these campaigns should be conducted.

To these meetings were invited representatives from some of the municipalities not represented on the committee to obtain the benefit of their experience in merchandising matters and to discuss with them various campaigns for which plans were being formulated.

The committee considered various phases of the Electric Range Campaign, the Lighting Campaign and the Water Heater Campaign as carried on by the Commission during the past three or four years, and the consensus of opinion among those present was that all three campaigns should be pushed with new vigor during the coming fiscal year.

In connection with the Range Campaign, endorsation was given to the policy of extending a $3.00 advertising allowance to dealers to help them advertise and push the sale of electric ranges, and the following resolution was adopted at the latest meeting:

"That the payment of the $3.00 allowance to dealers for each new electric range sold be continued."

It was also agreed that the policy of installing 3-wire services, either wholly or partly free, for purchasers of new electric ranges was a sound policy and one to be recommended to all Hydro municipalities for their adoption. The following resolution supported this recommendation:

"That the policy of installing free 3-wire services be recommended to all Hydro municipalities, local conditions to govern the set-up."

The forms of advertising which the Commission has been providing for the municipalities and dealers for range promotion and water heater advertising were reviewed, and it was recommended that this type of assistance to promote electric cooking and water heating be continued and that the municipalities and dealers be furnished with more and more diversified advertisements than in the past and with more frequent distribution of display material.

A suggestion that Hydro municipalities might finance electric ranges and other appliances through a finance corporation organized by Hydro municipalities was considered by the committee; it was decided, however, that such a plan would not be practical, and it was recommended that the present set-up, whereby municipal Hydro systems finance ranges and other appliances for their dealers and for their consumers, be promoted among other Hydro municipalities to make the practice more universal.

The subject of low priced electric ranges received considerable attention. It was agreed that there is a decided need for a lower priced range to satisfy the requirements of customers who are unable to pay for a

more expensive article. It was also pointed out that if such a range were placed on the market by all manufacturers, a large number of customers not now being served would purchase electric cooking equipment.

Attention was drawn to the policy being adopted by gas companies in bringing out a new low priced, high quality gas stove. It was also intimated that it is necessary for the electrical industry to face very keen competition from this source.

Several representatives outlined their experiences with one or two styles of low priced ranges which are on the market at the present time, and a proposal was made that the Sales Promotion Department of the Commission promote the production of low priced ranges by all manufacturers. This proposal was amended, however, and the following resolution adopted:

"That the low priced range situation be left as it is at present, and that all Hydro municipalities be notified of the prices on existing low priced ranges, pointing out the opportunities for purchasing a good low priced range."

In discussing the results to be obtained in carrying on campaigns of all kinds it was agreed that quotas should be established for each municipality as objectives for 1939 campaign efforts, and it was recommended that the Sales Promotion Department of the Commission assist the municipalities in arriving at these quotas.

In connection with the Water Heater Campaign, it was suggested that trained field men should be provided by the H.E.P.C. for the smaller municipalities to enable them to sell water heaters satisfactorily in the same way as lighting specialists are provided to sell lighting. The Committee is of the opinion that a great many more heaters could be sold in Hydro municipalities than at the present time if such an arrangement could be made.

The question of adding a free 3-kilowatt circulating type heater to our present set-up was considered by the committee. It was learned that in a great many instances a circulation type heater is more satisfactory for the small user than a flat rate heater would be. It was also mentioned that in Windsor such heaters and wiring are provided free, the customer paying for plumbing and tank insulation, if the latter is desired, and due to the peculiar conditions which exist in Windsor, mainly, gas competition, varying water temperatures winter and summer, and unemployment, the customers write their own ticket for water heater costs, and whereas flat rate heaters have been removed in large numbers, due to these conditions, the 3 kilowatt circulating type heaters are remaining in service.

The matter of controlling water heaters and charging for water heater service, where control is exercised, was also considered by the committee. The conditions under which water heaters are controlled at the present time in some municipalities and how they are to be controlled in the future received some attention. Several suggestions were made for the treatment of customers whose heaters are cut off during the peak periods. It was proposed that a discount be allowed,

or that larger sized heaters than necessary with uncontrolled service be installed and that the rates for controlled heaters be adjusted to take care of the cut-off period. It was agreed that wherever discounts or lower rates are established local conditions should govern these rates or discounts.

The general recommendations of the committee made at their spring meeting were embodied in the plans for the 1938 range, lighting and water heater campaigns, and at the fall meeting, after a general discussion on matters pertaining to the aforementioned campaigns, M. J. McHenry, Director of Sales Promotion of the H.E.P.C., described in detail the organization which is being set up by the Commission to carry on sales promotion work in the Hydro municipalities, outlining at the same time the program which is being developed for all sales promotion activities.

The committee was assured that their recommendations with respect to range campaigns, water heaters and lighting, would be given every consideration in planning all the Commission's future sales promotion activities.

Following this discourse the committee urged that the information imparted to the committee be given to both A.M.E.U. and O.M.E.A. delegates to the convention, and it was accordingly arranged that part of the session on Wednesday afternoon be set aside for this purpose, so that it will not be necessary to enlarge at this time on the organization or the activities which are being planned.

G. G. Cousins presented an outline of the plans which are being laid for carrying on a commercial lighting survey in all Hydro municipalities. Mr. Cousins described the method by which the present lighting staff of the Commission have been operating during the past 6 or 8 months, and the results which have been achieved, and pointed out that there is a big field for sales promotion in the industrial and commercial lighting field, but that its development depends upon the co-operation which all branches of the industry give to sales promotion effort.

G. W. Hague, MacLaren Advertising Company, outlined a plan for the promotion of a Sales Demonstration Week in many Hydro municipalities early in 1939.

The details of both of these activities will be fully described at the meeting tomorrow afternoon.

It was suggested to the committee that The Hydro-Electric Power Commission be urged to impress upon all Hydro municipalities the necessity for sales promotion work; that they endorse the policy of merchandising by Hydro municipalities and that they urge all commissioners in Hydro municipalities to take a keen interest in building up the load by promotion and other means at their disposal, and the following resolution was adopted:

"That the H.E.P.C. advise Hydro municipalities before the convention of the formation of a Sales Promotion Department and of the plans being laid, so that they can come to the convention prepared to discuss the matter."

A. W. BRADT,
Chairman.

# THE BULLETIN

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# Sales Promotion

## A Presentation of the Sales Promotion Programme of the Hydro-Electric Power Commission of Ontario

By M. J. McHenry, Director, Assisted by other Members of the Sales Promotion Department, H.E.P.C. of Ontario, G. W. Hague, Vice-President, MacLaren Advertising Company, Limited, Toronto, and J. W. Welch, Director of Sales Promotion, Edison General Electric Company, Chicago

*Mr. M. J. McHenry*

WE have been granted the opportunity, which we appreciate, of presenting to you this afternoon, information about the Sales Promotion Department of the Hydro-Electric Power Commission of Ontario, and something of the organization and campaigns which we are planning to develop during the course of the present year.

Time does not permit us to present a complete picture of the sales promotional effort which is being planned for this year, but we will endeavour to cover the highlights of the picture. Our program is designed for the benefit of the Hydro-Electric Power Commission of Ontario, and on behalf of the municipal enterprises and utilities in the province. It is likewise of much interest to the electrical industry as a whole.

Almost any other industry with which we are familiar today can point to the success which it has attained as being the result of a genuine, a sincere and a well planned and well operated sales promotion program. Therefore, why not the electric industry?

The Hydro municipalities and utilities in this province are ideally situated. Through the course of years, during which time the outstanding and widespread system of Hydro has grown, they have been successful in providing for the people of Ontario

Presented to the Ontario Municipal Electric Association and the Association of Municipal Electrical Utilities at Toronto, February 8, 1939.

## CONTENTS

**Vol. XXVI No. 3**
**March, 1939**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

very vital necessities in the form of electrical services which are denied to a great many sections of the people in other parts of Canada, and in other parts of this continent.

Yesterday afternoon, the rate system of the Hydro was amply and clearly dealt with, and comparative figures given. Further, the information given to you in respect to the extent of the growth of the Hydro system throughout this province was shown.

The low Hydro rates which are in use provide a foundation for optimism in the promotion of the whole electrical industry, and to provide additional benefits to the people of the province. Suffice it to say that we stand in a very ideal position in Ontario in respect to the further promotion of the great industry of which we all form a part.

The Hydro utilities and the electrical industry in Ontario are in a position today where they can do much to aid the question of unemployment, to improve the standards of living, and to add materially to the joy and comfort of living by promoting the use of electricity and popularizing the devices which operate by means of electric current.

There are three essential factors in respect to Sales Promotion. First, every representative of a Hydro municipality will surely agree that it is a fundamental duty of not only the Hydro-Electric Power Commission of Ontario, but of every Hydro municipality not only to provide for the people of this province the availability for use of electricity, but also to provide them with the information which will enable them to understand its use, and to make the most of it in their homes, in their stores, and in their factories. These ideas form the basis of the program which will be discussed today.

This department was inaugurated last fall, and is in the process of organization at the present time.

It will be our endeavour this afternoon to lay before you some of the plans already formulated, of the organization, how it will operate in the field so that you may have such knowledge as will enable you to co-operate with the Sales Promotion Department of the Commission to the greatest possible extent.

Permit me to stress, however, that the promotion of our industry, the promotion of the Hydro system itself and increase in its load and the effective dissemination of information pertaining to the uses of its product, can only be attained with maximum efficiency by a whole-hearted co-operation between the Hydro-Electric Power Commission and the constituent municipal systems, and by sincere co-operation of the whole electrical industry.

Any Sales Promotion program naturally divides itself into two main sections, first, advertising; second, field promotion. Advertising will be dealt with first, and the main points of this section outlined.

It is not generally possible from an economic or other angle, for the Hydro-Electric Power Commission to have a widespread provincial advertising campaign in the daily press. There are something like 27 daily newspapers in the Province of Ontario, and I believe something over 380 weekly newspapers as well. It will be appreciated that any attempt to carry space in the daily and weekly press by the Ontario Commission is an economic burden which cannot be undertaken.

Further, it has the disadvantage that it would not be as effective in municipalities as would the same, or even less amount of advertising done by the local utility. In general, therefore, such advertising becomes a part of the program of the municipal system who will have the assistance and co-operation of the Sales Promotion Department in supplying copy, cuts, etc.

Our advertising has been designed to carry a message to every section of business in the province. To meet this, it has been sectionalized into four schedules. The first of these sections is called Institutional Advertising. This is a general type which has as its object to disseminate general information and knowledge of the Hydro system, and to create a generous attitude of good will.

This Institutional Advertising will use as media such papers as the Financial Post, the Monetary Times, the Northern Miner, Gold, Canadian Business, Canadian News and other papers of similar type. A schedule has been set up which will provide a consistent and continuous use of these papers.

Another phase of this Institutional advertising is being carried out by means of a radio program. This went on the air for the first time last Thursday evening, February 2nd, at eight o'clock, on a chain of stations from Ottawa to Windsor. This radio program was publicized by newspaper advertising and through display cards forwarded to all municipal systems and electrical dealers.

If this program is to have full value, it is necessary that the listening audience be as large as possible, and we suggested to the municipalities that they advertise this in their local press, by imprint on their lighting bills, and in every possible way. The program is a pleasing one. We have had many favourable comments on it already, and I think you will find that the commercials on this program will be productive of much good. We are entering the homes of

the province in the cities and towns, and on the farm, and telling our story, with respect to lighting, domestic appliances, and Hydro devices generally.

A second type of our advertising is known as Commercial and Industrial. Here, we are seeking to carry a message to the retail trade throughout the province, and to industry generally.

The media chosen are such magazines as The Retail Grocer, The Canadian Grocer, The Baker and the Canadian Hotel Review, the Drug Trading, and other magazines reaching various other retailers throughout the province.

Here, we can tell the advantages of better lighting, commercial cooking, commercial refrigeration and air conditioning, all of which factors improve the conditions for the retail merchants.

Industrially, such magazines as the Textile Journal, Industrial Canada, and other magazines of this type, enable us to reach the industry of the province.

The next advertising group is that directed to the electrical trade and technical men. Here we reach the dealer section of our own industry, with the thought in mind that by helping them and stimulating their efforts, we will produce greater results for ourselves. The magazines chosen reach the electrical dealer, the contractor dealer, the hardware merchant and other people who are selling electrical equipment for use in the home.

An interesting type of advertising is that which we are doing in connection with the Hydro long-life lamp. A schedule has been set up using most of the daily papers in the province. In addition, we have prepared ready-to-run ads. for the municipalities' use, and hope that they will supplement our advertising generously.

The last section of our advertising is planned to use the farm papers, and directed to the rural areas. This will be referred to in more detail later in the afternoon.

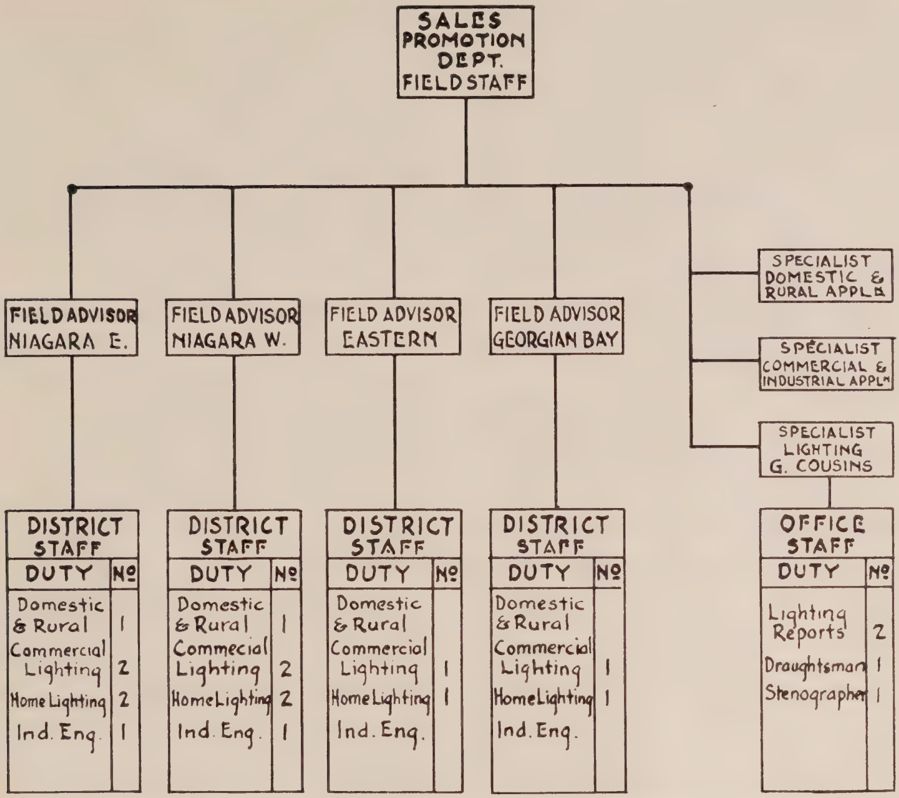
I have given a brief picture of the advertising which we plan to carry out on your behalf, and on behalf of the Commission during the course of the present year.

Advertising, however, is only one feature of promotional work. It is necessary to place in the field a promotional staff which will work for and with the municipal utilities, and assist in organizing campaigns of a promotional nature.

This organization is under way at the present time, and about seventy per cent completed. The accompanying chart indicates in some detail the organization which has been planned.

The province has been divided into four sections, parallelling similar divisions in the Municipal Department. The municipal engineers have in the past carried out considerable worthwhile promotion work, and they are vitally interested in such an endeavour. It is essential that the Sales Promotion Department and the Municipal Department work co-operatively in a promotion program, and with the municipal systems.

The Niagara system has been divid-




*Organization chart of field staff of the Sales Promotion Department.*

ed into two main territories, Niagara West and Niagara East, following similar division by the Municipal Department. In addition, there is the Eastern Ontario section, and a fourth, consisting of the Georgian Bay and Thunder Bay system.

In charge of Sales Promotion in each of these territories there is a Field Advisor, who will direct the efforts of the promotional men in such area, and under each of these Field Advisors are provided men to carry out the various features of promotional work.

Such features divide into three main classifications, domestic and rural applications, lighting applications (commercial, industrial and home lighting), and industry applications, or industrial engineering.

In each classification, specialized field men will operate under the direction of the Field Advisor.

To supplement these men in the field, there are three specialists in each of these technical classifications, that is, a specialist in domestic and rural applications, a specialist in commercial and industral applications, and a specialist in lighting. These men will initiate sales promotional methods for field men, and advise on specific technical propositions.

Under the Lighting Specialist, there is a lighting service section, which will prepare and send out lighting reports based on the information sent in by the field men. The lighting operation will be discussed in more detail later by Mr. Cousins.

The brief explanation I have given, will, I trust, demonstrate to you that we are putting man-power into the field to obtain the greatest possible results.

At this point, I would like to introduce (although he really needs no introduction to this audience) Mr. G. J. Mickler, Assistant Director of the Sales Promotion Department, who has an interesting story in respect to our rural program.

*Mr. G. J. Mickler*

Since the inception of Hydro, continuous efforts have been exerted to electrify farms throughout the province, and at the present time, the greater part of old Ontario has been divided up into Rural Power Districts, or areas where conditions make it possible to reach a large part of the farmers located in these territories. Rural power districts have also been created at the Eastern end of lake Nipissing, and in the Thunder Bay district, surrounding Fort William and Port Arthur.

Based on a survey which was made some time ago, it is estimated that on the basis of three customers per mile, there are approximately 75,000 standard or large size farms which can be served with electricity. With the change in requirements to two per mile, it is estimated that an additional 25,000 to 30,000 farms will come within reach of our rural distribution systems. At the end of 1938, the Commission was supplying power to approximately 46,000 of these potential users. At the rate at which new customers are being added each year, it is estimated that most of the farmers within reach, will be served within the next five or ten years.

The building of distribution systems in rural areas makes it possible to reach also a large number of small villages, hamlets and isolated inhabitants who would otherwise be without electric service, and in the areas served by the Commission a total of approximately 53,000 of these customers were supplied with Hydro service at the end of 1938, and while no accurate record is available of the numbers of these so-called hamlet consumers who can still be economically served, it is safe to say that within the next five or ten years a fairly large number of new consumers in this class will be added to our systems.

There are 177 operating rural power districts, supplying approximately 100,000 customers of all classes in 378 townships and 96 police villages, and these customers are served over networks of rural primary lines aggregating more than 15,500 miles.

The extent to which Hydro service is being developed is revealed in the following table (Table No. 1), which shows the number of hamlet and farm customers served at the end of 1937, those added to our lines in 1938, and the prospects for new customers for 1939 in each of the systems operated by the Commission.

It is apparent from the figures

TABLE NO. 1

| | Customers at end of 1937 | | | Added in 1938 | | | In Prospect 1939 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Hamlet | Farm | Total | Hamlet | Farm | Total | Hamlet | Farm | Total |
| Niagara System | 30,180 | 27,831 | 58,011 | 1,439 | 5,149 | 6,588 | 1,918 | 4,139 | 6,057 |
| Georgian Bay System | 7,076 | 3,208 | 10,284 | 1,520 | 1,149 | 2,669 | 1,095 | 938 | 2,033 |
| Eastern Ontario System | 10,040 | 6,510 | 16,550 | 1,406 | 2,021 | 3,427 | 1,246 | 1,855 | 3,101 |
| Thunder Bay System | 263 | 175 | 438 | 64 | 102 | 166 | 44 | 132 | 176 |
| Manitoulin System | 192 | 39 | 231 | 66 | 47 | 113 | 25 | 23 | 48 |
| Nipissing System | 465 | 38 | 503 | 37 | 16 | 53 | 21 | 33 | 54 |
| Total | 48,216 | 37,801 | 86,017 | 4,732 | 8,484 | 13,016 | 4,349 | 7,120 | 11,469 |

shown above that the additions to our customer list during the past year and prospects for the present year make up a sizeable total. Expressed in terms of a single community 24,000 odd customers would equal a city of approximately 120,000 people, and when it is realized that all of these customers are starting from scratch, insofar as electric equipment is concerned, the value of the market for electrical equipment which is created by these customers, can be appreciated.

It is estimated that the average customer requires from \$100.00 to \$200.00 to wire his premises and that he should spend from \$200.00 to \$300.00 on equipment before he can make use of Hydro, so that the immediate market during these two years, 1938, and 1939, would appear to be between \$8,000,000.00 and \$12,000,000.00.

The extent to which rural customers of the province have been electrifying their homes and their farms, is revealed in the following table, No. 2, which shows the number of electrical appliances in the use by Hydro Rural customers at the end of 1937, and the saturation which has been reached for each.

Assuming that the customers who are added each year represent a fair cross-section of average rural customers, it can be estimated also that their immediate requirements will be equal to the use which is being made of Hydro service by customers already being served, and a study of the figures of Table No. 2 will give some idea of the market which really prevails for all types of

TABLE NO. 2

| | Hamlet Consumers | | Farm Consumers | |
|---|---|---|---|---|
| | No. of Appliances | % of Saturation | No. of Appliances | % of Saturation |
| **In the Home** | | | | |
| Electric | | | | |
| Range | 4,992 | 11.26 | 6,462 | 16.97 |
| Hot Plate | 9,600 | 21.65 | 8,300 | 21.80 |
| Washers | 18,599 | 41.94 | 21,909 | 57.54 |
| Vacuum Cleaner | 5,365 | 12.10 | 4,859 | 12.76 |
| Water Heater (Flat Rate) | 993 | 2.24 | 1,281 | 3.36 |
| Water Heater (Metered) | 781 | 1.76 | 637 | 1.67 |
| Grate | 340 | .77 | 288 | .75 |
| Air Heater | 3,379 | 7.62 | 3,748 | 9.84 |
| Ironers | 402 | .91 | 459 | 1.21 |
| Irons | 30,142 | 67.98 | 28,672 | 75.31 |
| Refrigerators | 4,177 | 9.42 | 3,786 | 9.94 |
| Toasters | 20,642 | 46.55 | 19,941 | 52.37 |
| Radios | 28,237 | 63.68 | 26,090 | 68.52 |
| Furnace Blower | 678 | 1.53 | 540 | 1.42 |
| Pumps | ........ | ........ | 5,603 | 14.72 |
| **In the Barn** | | | | |
| Electric | | | | |
| Motor | ........ | ........ | 6,462 | 16.97 |
| Pump | ........ | ........ | 4,939 | 12.97 |
| Grain Grinder | ........ | ........ | 2,087 | 5.48 |
| Milking Machine | ........ | ........ | 986 | 2.59 |
| Milk Cooler | ........ | ........ | 553 | 1.45 |
| Cream Separator | ........ | ........ | 2,356 | 6.19 |
| Churn | ........ | ........ | 367 | .96 |
| Incubator | ........ | ........ | 419 | 1.10 |
| Brooder | ........ | ........ | 322 | .84 |
| Hot Bed | ........ | ........ | 39 | .10 |
| Water Heater, F.R. | ........ | ........ | 55 | .14 |
| Water Heater, Met. | ........ | ........ | 47 | .12 |
| Air Compressor | ........ | ........ | 66 | .17 |
| Battery Charger | ........ | ........ | 55 | .14 |
| Miscellaneous | ........ | ........ | 332 | .87 |

electrical equipment for the home and for farm use to bring saturation of new customers up to that of those already being served.

Among 15,000 new farm customers, there is a ready market for approximately:

| | | |
|---|---|---|
| 2,500 | Electric | Ranges |
| 3,000 | " | Hotplates |
| 8,500 | Electric | Washing Machines |
| 2,000 | " | Vacuum Cleaners |
| 750 | " | Water Heaters |
| 1,500 | " | Air Heaters |
| 15,000 | " | Irons |
| 1,500 | " | Refrigerators |
| 7,500 | " | Toasters |
| 10,000 | " | Radios |
| 4,000 | " | Pumps |

| | | |
|---|---|---|
| 2,000 | Electric | Motors |
| 800 | " | Grain Grinders |
| 500 | " | Milkers |
| 300 | " | Milk Coolers |
| 1,000 | " | Separators |

and innumerable other smaller appliances, while among 9,000 hamlet customers there is a ready market for:

| | | |
|---|---|---|
| 1,000 | Electric | Ranges |
| 2,000 | " | Hotplates |
| 4,000 | " | Washing Machines |
| 1,000 | " | Vacuum Cleaners |
| 400 | " | Water Heaters |
| 700 | " | Air Heaters |
| 9,000 | " | Irons |
| 900 | " | Refrigerators |
| 4,000 | " | Toasters |
| 6,000 | " | Radios. |

Referring again to Table No. 2, it is apparent that there are a large number of appliances, the use of which is far below what is actually necessary on the average farm of to-day. If we consider the farmer as an industrialist in competition with other farmers, we must realize that in order to compete successfully, he should equip his factory with every labor saving device at his disposal.

Then, if we compare the use which is made of electrical equipment in the home among hamlet users in rural areas with that of urban customers, we will find that in many instances, the saturation in the rural communities is very much lower than that of the towns and cities, so that while there is an immediate market among new customers to produce normal saturation, there is also a possible market among existing and new customers to bring the level of saturization up to the average in urban centres and beyond.

One of the prime essentials in developing a market such as this, is education and publicity, and in planning our Rural Campaign arrangements are being made to convey to existing customers and prospects all the information possible on the use of electricity on the farm and in the home. Pamphlets will be prepared on adequate wiring and on lighting, electric cooking and on some of the larger pieces of farm equipment. Arrangements have been made with the principal farm magazines of the province to devote considerable editorial space in their magazines to the use of electricity among rural consumers. The Commission intends to support this editorial service with advertisements which will bring to our customers, and to prospects, essential information on the application of electricity to operations so necessary to rural dwellers. The Hydro Radio program will also be used to spread Hydro information to our rural consumers.

The Commission is also equipping one or more travel shops with electrical equipment by means of which all types of electrical appliances will be demonstrated to large numbers of rural users all over the province. These travel shops will be manned by crews capable of demonstrating the use of all types of equipment, and explaining the benefits of such use to those who seek this information. The travel shops will move from one rural power district to another, and to smaller municipalities, on a regular schedule where the sales crews

will canvass prospects who have been developed from time to time, and conduct cooking schools and demonstrations for the benefit of individuals or groups. These demonstrations will include entertainment suitable for the occasion.

The Electric Range Campaign which has been carried on in the rural districts for the past two years will be continued, and the $20.00 allowances which the Commission has been making to purchasers of new electric ranges in lieu of wiring, will be continued. The plan by which free water heaters will be installed for rural customers will also be carried on, and from time to time, other campaigns, embracing lighting and other farm equipment will be instituted, so that every opportunity will be given to rural customers to take advantage of the facilities which are provided in urban centres to become users of Hydro to the fullest possible extent.

Facilities are now available to farmers to finance the purchase of wiring and electrical equipment for farm use through the medium of "The Rural Power District Loans Act" which has been in operation since 1931, and the plan by which new electric ranges are financed for all types of rural consumers, is being continued.

The Commission is planning to cooperate with all branches of the electrical industry in every way possible, through cooking schools, demonstrations, fall fairs, and otherwise, to bring before our rural customers all of the information which they may desire to fully electrify their homes and farms.

In order to familiarize the industry with our plans, a pamphlet has been issued for distribution to manufacturers, jobbers, dealers and all rural offices. In this pamphlet, much of the information imparted above will appear, as well as an outline of the Commission's rural advertising and other promotional activities.

*Mr. McHenry*

I would like to add that this Rural Advertising Campaign pamphlet is available now for Hydro systems and rural power districts. Sales promotion work must incorporate campaigns from time to time if it is to engender enthusiasm and stimulate the industry to obtain full results. Several of these have been planned.

The range campaign will be continued this year. It is our intention to carry it along much the same lines as formerly, but we have added some new and interesting features.

In the fiscal year ending October 31, 1938, our records show that approximately 9,200 new electric ranges were installed during that year in Ontario. This number is not complete, because a great many of them were not registered through the dealers, but probably there were approximately 10,000 ranges installed. It is our objective for this present year, to establish a quota for the Province, and endeavour to set up a mark at which to shoot. Such quota is established at the figure of 13,000 electric ranges.

Such quota will be broken down for each municipal system, and for

each rural power district, so that everybody will have a corresponding mark at which to shoot, and we hope with the united effort of all, we will attain that quota.

In Range Campaign advertising, we have introduced some features this year which have been requested by various municipalities. A Hydro 1939 Range campaign book is now being prepared, and will be forwarded to you shortly.

This range manual contains, in addition to a general message, recommendations of the many things that municipal systems may do in order to promote actively, greater range business with the electrical dealer outlets, a recommendation to finance range sales, both for the Hydro shop and for all dealers, and a further recommendation to supply either in whole or in part, the cost of range wiring and installation. It is also recommended that the municipalities carry on a local advertising campaign in the press with particular reference to range sales.

The annual quota for ranges is given in this bulletin by sections of the province, and will be further amplified with each municipality by the men of the Sales Promotion, who will provide the annual quotas for each Hydro system.

A great portion of this range bulletin is given up to illustrating the prepared advertisements which can be used by the municipalities for local advertising. We have endeavoured to make these as attractive as possible, and mats and stereos of them can be supplied to all municipalities, free, on request. Some of the municipalities suggested that they would like to have cuts supplied which would enable them to prepare their own advertising, and this has been included in the range manual, so that by ordering the necessary cuts, etc., any system can make up its own newspaper advertising. Many requests are received for feature stories in respect to electric cooking, electric kitchens, etc., and these are contained in the bulletin, and the necessary cuts can be obtained as required.

As heretofore, an attractive piece of floor display material is illustrated in this bulletin, and will be supplied, free, on request, to the various municipalities. We suggest that the Hydro systems not only use these on their own floors, but endeavour to get the dealers to use them.

In previous years, a promotional allowance of $3.00 per range was paid. This allowance was paid to every dealer or Hydro shop that registered with the Sales Promotion Department, the installation of a new range of 60 amperes capacity, or larger. This allowance will be continued in the course of this year's campaign and we will recommend that the amount obtained therefrom by the Hydro system or the local dealer, be used for the purpose for which it was intended, namely additional promotional effort. We will not further enlarge on the range campaign at this time, as you will have the complete information through the range bulletin shortly.

In our classifications of work in

the Sales Promotion Department, we have pointed out that lighting plays a prominent part. Daily, it is being brought to our attention that better lighting with its increased load, and additional revenue, particularly among commercial consumers, presents a very worthwhile objective. At this morning's session, a paper was presented, advancing many of the very valuable characteristics of this particular field of promotion. The Sales Promotion Department has prepared itself to assist the municipalities to foster this particular field as much as possible. Therefore, at this time, I take a great deal of pleasure in asking Mr. G. G. Cousins, our specialist in lighting, to outline to you some of the operations of the lighting section of the Sales Promotion Department.

*(To be Continued)*

## WINTER TROUBLE SHOOTING

The odds that a Hydro repair crew may be required to work against is aptly illustrated in the following news item that appeared in a recent edition of *The Evening Telegram* of Toronto:

BATTLE SNOWS FOR TWENTY MILES
FIND TROUBLE SOMEONE ELSE'S

"Meaford, March 2 (Special)—When a group of Euphrasia Township children decided to 'play safe' after finding a broken wire across the road, they caused an exciting day for the whole district and won themselves a holiday from school.

"They had been warned repeatedly that any time they found a Hydro wire down they should keep clear of it and report immediately.

"On their way to schood they discovered a wire trailing across the road. An insulator hung from one end. It barred the way to school, so they were doubly glad to obey instructions.

"Nearby farmers were told. They passed word to Meaford from whence the call went to district Hydro headquarters at Owen Sound. A repair crew started for the scene and in the meantime the road was blocked to traffic.

"The repair crew battled 20 miles through deep snow to the nearest point on the main highway, moved their equipment onto a sleigh and were drawn by horses for the last six miles.

"Arriving weary and cold, they looked at the wire. 'That's a telephone wire—nothing to do with us,' they said, and started the long journey home."

* * * *

The children are to be commended for following instructions to keep away from wires they may see down and for reporting the same. They cannot be expected to judge between a dangerous Hydro wire and a harmless one belonging to some other service. —EDITOR.

# Wire Mileage Map

By W. R. Catton, Manager Hydro Department, Public Utilities Commission, Brantford

*(Presented to the Association of Municipal Electrical Utilities at Toronto, February 8, 1939)*

YOUR system balance sheet will indicate total value of plant as Lands and Buildings, Sub-Station Equipment, Distribution System Overhead and Underground, Transformers, Meters and Street Lighting. All of these items are comparatively simple to keep by records, except Distribution Overhead; Distribution Overhead consisting of poles, cross arms, hardware, wire, etc., covering every street in your municipality and many of the individual poles carrying every type of circuit. This mass of detail on a standard city map, quickly becomes a blur if the system is subject to continual pole and wire changes.

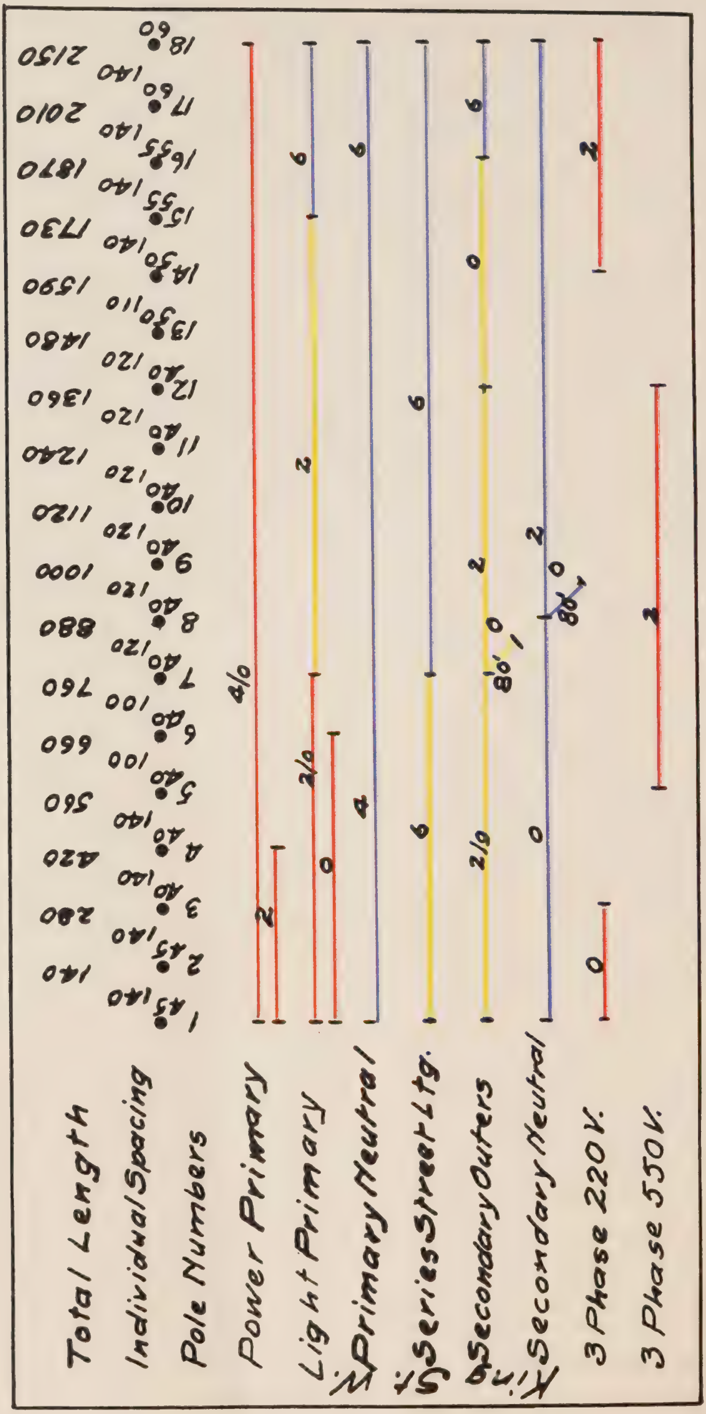
Our wire record, as the sample indicates, consists of a loose leaf binder containing sheets of a light blue block paper, 8 in. by 30 in. Each sheet will take care of a street 10,000 ft. long.

To compile such a record is quite a task, but once completed, is quite easy to maintain and keep up to date. As will be noted, each pole is numbered—the nail type number being used. The length of pole is indicated and also the pole spacing. Finally, the totals of the individual pole spacings. The types of circuits in your municipality can be stamped in with a rubber stamp made up in one block.

The wire data is represented by three colours: red, 3-wire; yellow, 2-wire; and blue, 1-wire. A small lead pencil mark placed at the junction of two wire sizes and also the size indicated with lead pencil is easily changed.

The summary sheet, as you will note, is quite simple. All figures are in lead pencil because these figures change with wire change. The totals of wire size, length, weight, etc., is easily taken on an adding machine. The information covering cross arms, hardware insulators, etc., can be visualized from the map. For instance, two lighting and two power primary circuits are indicated. This calls for two 6-pin arms with neutral on top of pole. A 6-pin arm takes care of the 220 and 550-volt power secondaries and a 4-pin arm will handle the lighting secondaries and series street lighting.

We have found after a few years' experience with this type of wire map, that it gives in a simple way a good picture of one of our largest items of capital expenditure. We are also able to secure very accurate data on wire mileage as used in the operating analysis on which rates are set for the various services in the municipality.




*Sample wire record. Records are made on blue block paper. The wire data are shown in three colours: red, 3-wire; yellow, 2-wire; blue, 1-wire—with coloured pencils. Junctions and wire sizes are indicated in lead pencil.*

SUMMARY SHEET

| *Wire Size* | *6* | *4* | *2* | *0* | *00* | *0000* |
|---|---|---|---|---|---|---|
| Power Primary. | | | 1260 | | | 6450 |
| Light Primary. | 420 | | 1940 | 1980 | | |
| Primary Neutral. | 420 | 1730 | | | | |
| Series Street Ltg. | 2910 | | | | | |
| Secondary Outers. | 280 | | 1200 | 1180 | 1520 | |
| Secondary Neutral. | | | 1270 | 960 | | |
| 3 Phase 220 Volt. | | | 1680 | 840 | | |
| 3 Phase 550 Volt. | | | 2400 | | | |

*Table giving totals of wire lengths of the different sizes. Wire lengths are entered with lead pencil to permit easy revision if changes are made.*

# Theoretical Derivation of a Potential Transformer Ratio Test Method

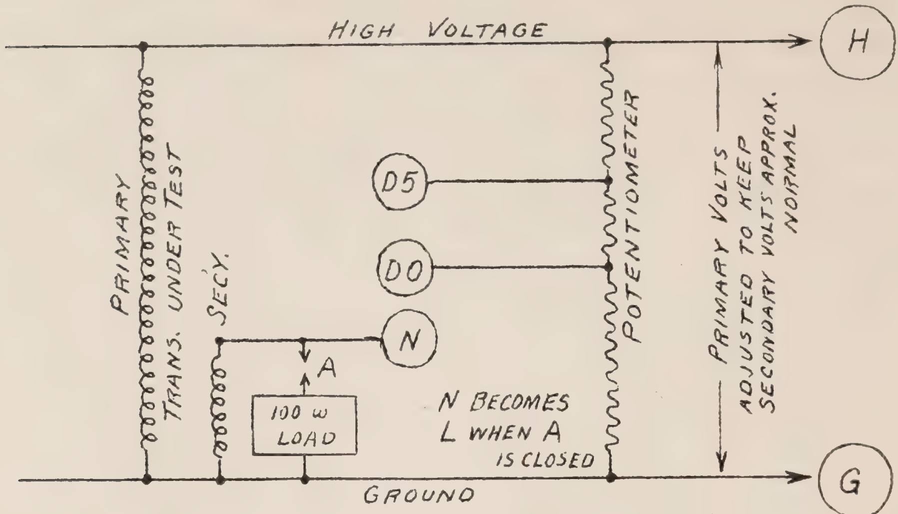
By H. S. Baker, Meter Supervisor, H.E.P.C. of Ontario

THE above is a "*deflection potentiometer*" method using an ohmic potentiometer connected across the primary voltage and having two accurately placed taps, one at the "*nominal ratio*" point, and one at a known "*artificial error*" point.

This is an "*absolute method*" of ratioing, because it does not depend upon the calibration of any devices in adjusting the set-up.

When using a "*deflection method*" of potential ratioing, a small current is drawn from the tap of the ohmic potentiometer while readings are being taken. This disturbs the ratio of the voltages upon the two sections of the potentiometer, but it does not introduce an error into the test method, because an ohmic potentiometer with current drawn from its tap behaves in exactly the same manner as an imaginary ideal (fixed ratio) potentiometer plus a resistance connected in its tap, that is equal to the combined parallel resistance of the two sections of the potentiometer. This parallel resistance value is the "*output resistance*" of the actual potentiometer tap.

In the present method we must be




"SPACE DIAGRAM"
FIG. 1

sure that the following two sources of error are not significant:

1. The presence of reactance in the ohmic potentiometer elements.

2. The "bleeding" of a part of the potentiometer current, from certain sections via capacity couplings to ground or elsewhere.

In the present design, No. 38 "advance" resistance wire is used, wound in a single layer on ⅛ inch bakelite cards. The reactance figures to about 0.002 of one percent of the ohmic resistance, which is negligible.

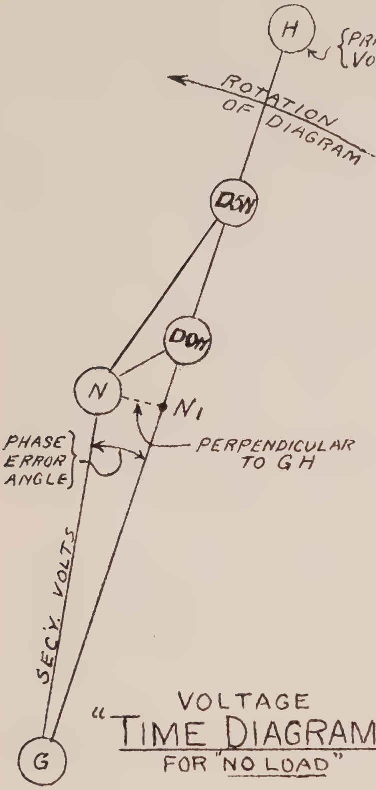
In regard to capacity couplings, tests were made using artificial capacity couplings which were known (by dimensions) to be several times as great as those inherent in the design. These couplings were made and broken during a ratio test, and the effect upon the results was not readable for ratio, and was negligible for phase errors. The sensitivity of the test was about 0.03 percent for ratio and 1 minute for phase error.

The potentiometer is operated (for all ratios) at about 21 ohms per volt. Taps at various points are brought out to suit various high tension voltages. There are two taps near the 100 volt point. One is at the exact "*nominal ratio*" point, and one is above this at 5 percent more resistance from the ground end of the potentiometer.

These two taps are called "D0" and "D5".

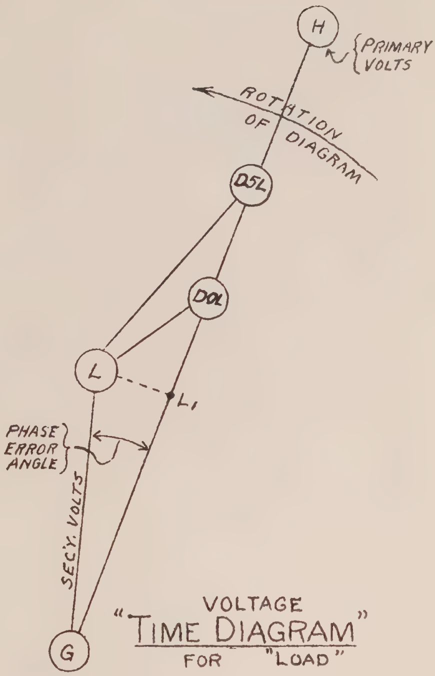
A wattmeter type detector whose coil circuit is connected across the voltage to be measured, has its field fed from either of two sources of voltage which are 90 degrees apart. One source is called "V" and one is called "H" (which lags "V" by 90 degrees). The voltage sources "V" and "H" are derived from an ohmic network* which is fed from a sub-

*See note on page 89.




VOLTAGE
"TIME DIAGRAM"
FOR "NO LOAD"

FIG. 2




VOLTAGE
"TIME DIAGRAM"
FOR "LOAD"

FIG. 2A

stantially balanced three-phase supply. The voltage distortion of the network caused by drawing current from it does not cause an error of the 90 degrees relation, for reasons similar to those given above regarding the distortion of voltages in the ohmic potentiometer.

When this detector coil circuit is connected across, say D5 to N in Fig. 1, the two readings "V" and "H" determine a vector which is an unknown fraction of the open circuit voltage between D5 and N. The phase relation of this vector to the above open circuit voltage is also unknown. However when the four vectors mentioned below are read and plotted, the relations between them are the same as between the corresponding open circuit values, because care has been taken to keep the impedance of the complete circuit (closed by connecting in the detector coil) constant for all four vectors.

This impedance is made up of three parts:

1—detector coil circuit impedance.

2—potentiometer tap "output impedance".

3—potential transformer impedance.

In the above, No. 1 and No. 3 are substantially fixed in regard to the total circuit impedance. No. 2 is greater for the D5 tap than for the D0 tap, and when using the D0 tap, a suitable value of extra resistance is automatically cut into the circuit.

The four vectors that are read are as follows:

(D5N — N) with switch A open for no load reading—Fig. 2.

(D0N — N) with switch A open for no load reading.

(D5L — L) with switch A closed for load reading—Fig. 2A.

(D0L — L) with switch A closed for load reading.

Fig. 2 shows the voltage *"time diagram"* of the hook-up for the no load condition with switch "A" open. Similarly Fig. 2A shows the diagram for the load condition.

In Fig. 2 we have the following relations:

Nominal ratio is (H — G)/(D0N — G).

Actual ratio is (H — G)/(N — G).

Phase error angle is $NGN_1$.

The value of (D5—D0N) has been made exactly 5 percent. of (D0N — G).

The meaning of *"percent. ratio"* is taken as $100 \dfrac{\text{actual ratio}}{\text{nominal ratio}}$

Fig. 3 shows two diagrams such as Fig. 2 (superimposed for convenience). One is a part of Fig. 2 (for "no load"), and the other is a similar part of Fig. 2A for the load condition. In these two diagrams the secondary voltage vector (N—G) is common. This gives two positions for the primary voltage vector.

In Fig. 3 the point D5L is determined by the "V" and "H" readings "P" and "Q". Similarly D5N, D0N and D0L are plotted.

A line is drawn through D5N and D0N. Also a line is drawn through D5L and D0L. A perpendicular is dropped from N or L on the first line. This determines the point $N_1$. Similarly a perpendicular on the second line determines $L_1$.

The distance from D0N to D5N (measured to some convenient scale) is called "S", with its positive direction towards D5N. "S" is always positive.

The distance from $N_1$ to D0N (to the same scale) is called "R". This may be positive or negative. "R" is shown positive in Fig. 3 and negative in Fig. 3A.

The distance from L or N to D0N (to the same scale) is called "T". This always appears as a square term, and its sign is always scaled off as positive.

The distance from N or L to $N_1$ is called "U" (to the same scale). "U" is positive for secondary volts leading as per Fig. 3, and is negative for secondary lag as per Fig. 3B.

From the data described above the following relations are easily deduced.

$$\text{"\% Ratio"} = \frac{100}{\sqrt{1 - \dfrac{R}{10S} + \left(\dfrac{T}{20S}\right)^2}} = \frac{100}{1 - \dfrac{R}{20S}} \text{ approx.}$$

$$\text{"\% tangent of phase error lead"} = \frac{100\,\dfrac{U}{S}}{20 - \dfrac{R}{S}}$$

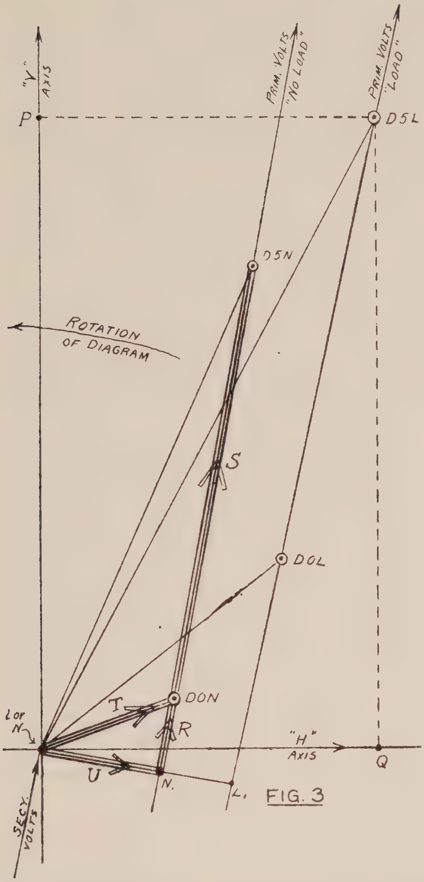



FIG. 3

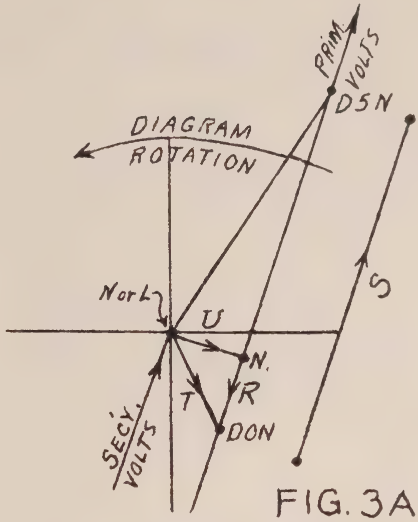



FIG. 3A

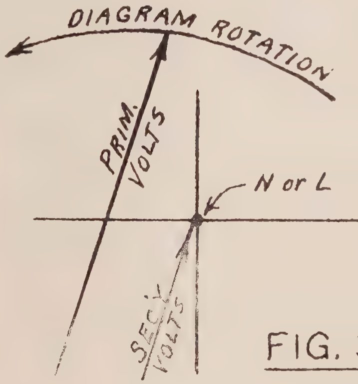



FIG. 3B

The approximate formula for ratio is derived by the following transformation in the quantity under the square root sign.

$$1-\frac{R}{10S}+\left(\frac{T}{20S}\right)^2=$$

$$\left\{1-2\left(\frac{R}{20S}\right)+\left(\frac{R}{20S}\right)^2\right\}+\left\{\left(\frac{T}{20S}\right)^2-\left(\frac{R}{20S}\right)^2\right\}=$$

$$\left(1-\frac{R}{20S}\right)^2+\frac{T^2-R^2}{400S^2}=\left(1-\frac{R}{20S}\right)^2+\frac{U^2}{400S^2}$$

For small phase errors the value of $\frac{U^2}{400S^2}$ is small and may be neglected.

For phase error zero, $\frac{U^2}{400S^2}=0$.

For 1 percent. phase error (= 34.4 minutes), $\frac{U^2}{400S^2}=\frac{1}{10000}$

For 5 percent. phase error (= 172 minutes), $\frac{U^2}{400S^2}=\frac{1}{400}$

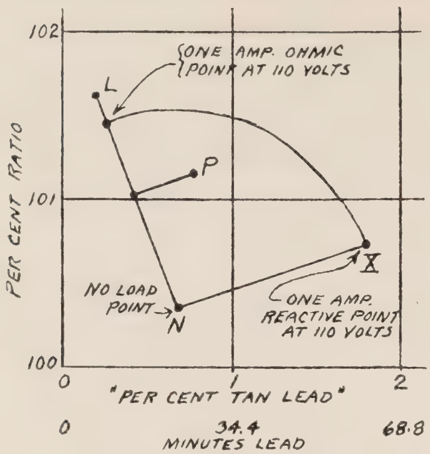



FIG. 4

Hence, use of the approximate formula would change the value of the ratio only

$\frac{1}{200}$ of 1 percent. for 34.4 minutes phase error, and

$\frac{1}{8}$ of 1 percent. for 172 minutes phase error,

which is less than the other unavoidable errors under such strenuous conditions of test.

In Fig. 3 the four quantities R, S, T and U are indicated for the *"no load test"*.

The corresponding values for the *"load test"* are:

R = $L_1$ to D0L
S = D0L to D5L
T = (L or N) to D0L
U = (L or N) to $L_1$

We now have ratio and phase error values for *"no load"*, and for *"100 ohms ohmic load"*.

Whether the test is run at exactly the *"nominal secondary voltage"* or not, we will designate (for purposes of plotting in Fig. 4) the *"secondary amperes"* as resulting from *"nominal secondary volts"* as applied to 100 ohms ohmic resistance. This amperage might be 1 ampere or 1.1 amperes as determined by the *"nominal secondary voltage"* being 100 volts or 110 volts. Of course the test is actually run with the actual secondary volts close to nominal value.

It should be noted that a potential transformer feeding a fixed impedance load has almost fixed ratio for varying voltage within reasonable limits of voltage.

Hence, ordinary curves of ratio versus amperes, or curves of ratio versus volt-amperes load, must have actual amperes or volt-amperes corrected from actual voltage to nominal voltage before picking out actual ratio on the curve. The amperes vary as the volts, while the volt-amperes vary as the square of the volts.

From the above ratio and phase data of two known conditions, *"no load"* and *"100 ohms load"*, we will construct a diagram Fig. 4 from which the ratio and phase errors may be read off to suit any load, either ohmic or partly reactive. Fig. 4 shows such a diagram as devised by C. W. Baker.

A scale of ordinates is assigned which represents *"percent of nominal ratio"*.

A scale of abscissae is assigned which represents *"percent tangent of phase error angle lead"*.

One percent on one scale must equal one percent on the other.

A scale of "minutes" phase lead may also be laid off by making 34.4 minutes equal to 1 percent.

The test results are plotted at N

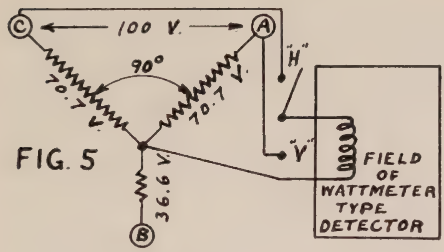


FIG. 5

and L, Fig. 4 showing the *"no load"* and *"load"* results of test. If the "load test" figures to 1.1 amperes at *"nominal secondary voltage"* then the distance from N to L represents 1.1 amperes.

A "one ampere' ohmic load point is determined by going 10/11 of the way from N to L, Fig. 4. A circle is drawn through the one ampere point with N as its centre.

A right angle LNX is drawn, determining the point X which gives the ratio and phase error for one ampere purely reactive load at *"nominal secondary volts"*. Should the rated secondary voltage be 110, and the actual secondary voltage be, say 95 (in a certain case), then in order to apply the above diagram we proceed as follows:

If the measured "in step" secondary amperes at 95 volts be 0.6 and the reactive be 0.2, then multiplying each by 110/95, we get 0.696 ohmic and 0.232 reactive. We now proceed from N a distance of 0.696 amperes towards L, and thence at right angles a distance of 0.232 amperes to the point P, which determines the ratio and phase error in the above given case.

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Note (see page 84):—

### Ohmic Network For Supplying Detector Field Coil

A simple network for supplying quadrature voltages to the detector field coil is illustrated in Fig. 5. Three phase supply is applied to points A, B and C. This may be 110 volts, or other suitable voltage but the values marked are based on 100 volts applied. If resistances of the three legs are denoted $R_A$, $R_B$ and $R_C$ respectively, then $R_A = R_C$ and $R_B$ should be $0.366R_A$.

Output resistance equals parallel connection of the three legs or $0.577R_B$.

With short from A to P, current would be $\frac{70.7}{0.577R_B} = \frac{122}{R_B}$ amperes.

*Alexander Development, Nipigon river.*

# Commercial Lighting Trends and Sales Possibilities

By B. W. Grover, Lighting Service Department, The Public Utilities Commission, London

*(Presented to the Association of Municipal Electrical Utilities at Toronto, February 8, 1939.)*

THE merits of commercial lighting have been discussed so much during the past few years that it is unnecessary to include them in this paper. Instead the following summary offers interesting evidence of its possibilities from actual results. Similar or better results have been achieved in other towns and cities where campaigns have been conducted.

| | Commercial kw. added | Estimated Revenue | Est. Commercial Promotional Exp. |
|---|---|---|---|
| 1935 (Half year) | 125 | $3,750.00 | $3,250.00 |
| 1936 | 248 | 7,290.00 | 7,150.00 |
| 1937 | 257 | 7,710.00 | 6,850.00 |
| 1938 | 268 | 8,040.00 | 6,500.00 |
| | 888 | $26,790.00 | $23,750.00 |

Briefly, 888 kw. have been added at a cost of $23,750.00 bringing in a revenue of $26,790.00 per annum.

Such results are comparatively easy to obtain and offer the utility a profitable, high load factor, field that in the past has received very little sales attention.

Consideration should first be given to a customer's circumstances before any recommendation is offered. What he sells, what his business can afford, whether he owns or leases the building, whether he may have to compromise with other principals in the business and other seemingly irrelevant items must be taken into account before making a recommendation which will have every chance of being accepted. Repeatedly, attempts are made to induce lighting prospects to install most expensive types of modern lighting without cognizance of the fact that he must cut his coat according to his cloth. Since accepting this fact it has been possible to work with and for customers without incurring their resentment by embarrassing them with expensive, and to them, fanciful suggestions. Usual practice is to submit two layouts, a first consideration and a cheaper alternative, but even the first consider-

ation is kept down to what is considered the customer's limit.

When the consumer wishes to obtain more light at the least possible cost, the easiest solution is putting larger lamps in the present fixtures. Unfortunately this simple solution cannot often be adopted as usually he is already using the largest possible lamps and, in the majority of cases, his circuit wiring and often his service is already overloaded. It is also stressed that when this easy solution is adopted it is just as easy for the customer to revert to his former standards. Persistant and careful salesmanship is justified to make a conversion to better lighting.

In many cases it is possible to augment existing lights by adding indirect units on tops of wall and fixture cases. There are several cheap and efficient boxlites, urns and pedestals on the market for this purpose which sometimes may be plugged directly into baseplug receptacles which are not loaded. Downlights over counters and displays is another alternative. These may be fastened to or recessed in the ceiling and as they rarely use more than 200 watts do not require much additional wiring. Such additions should be carefully planned as the first step in a gradual change to a modern lighting system. Wiring specifications should be prepared and service, panels and feeds specified for the complete renovation but only the necessary work to take care of immediate requirements is installed.

Such "progressive" layouts are particularly valuable to the consumer who cannot afford, at present, major alterations. It enables him to budget his expenditure and make additions when he can best afford it and he is assured that there is no overlapping in material or labour to increase the ultimate cost. The utility is enabled to keep close touch on a basis of service rather than sales which makes for better relations on both sides. In London some of these customers whose original attitude towards the Commission was decidedly cool now call the Lighting Service Department for any problem that may arise from city taxes on signs to complaints about the waterworks. It has appeared that many appreciate seeing the utility merchandise electricity on a basis similar to their own method of selling and prefer to be told candidly that the utility is engaged in selling more hydro.

It is frequently impossible to apply any of the foregoing methods, then the only alternative is to press the idea of new fixtures. A new use may be found for existing fixtures in the bargain basement, on the second floor or in a neighbourhood store the customer may own, and so lessen his objection to the expense of new fixtures.

Where the customer has been convinced of the necessity for replacing his existing fixtures next comes the choice of the new fixture. This is determined largely by the type of merchandize being sold by the customer. For example, jewelry, furs or china require some type of direct lighting to give sparkle and sheen. Other types of merchandize display to their best advantage under indirect light. A combination of both

systems either by direct/indirect fixtures, or by indirect fixtures and downlights mounted on the ceiling or set in flush, is sound practice. The present trend appears to be definitely towards this method for nearly all types of stores. The downlights supply the high intensities necessary to display the goods properly and the indirect light softens the sharp shadows caused by the downlights and supplies that "atmosphere" which is so pleasing in a well designed indirect lighting installation. Thus is supplied a more rational installation that gives much higher intensities where required without great increases in connected load and represents an important forward step in the lighting field.

Direct lighting fixtures have been greatly improved in the past few years and there is little comparison between the present streamlined lens, louvred or glass unit with glaring parts carefully shielded and its counterpart of a few years ago, like the opal enclosing globe profuse with ornaments and crystal bottom. There are many efficient and pleasing designs both for direct and indirect units that have appeared on the Canadian market in the last year or two and the lighting engineer is no longer hampered by lack of suitable equipment to recommend.

In the case of the merchant undertaking a complete renovation and modernization of his premises, the lighting engineer, designer and contractor can work hand in hand to produce an installation peculiar to the needs of the store and not easily duplicated by competitors or others.

The light sources may be made an integral part of the building and fixtures, so that the source of light is not readily apparent but only its effects are observed. The merchant who undertakes major alterations and fails to tailor his lighting therewith misses a splendid opportunity of jumping two to five years ahead of his contemporaries. It is conceded by those who have made such alterations that, dollar for dollar, their lighting installation showed better results than any other change adopted.

The scope of tailored lighting is limited only by the ingenuity of the designer and, of course, the customer's pocket book. The most popular trend is an indirect and direct lighting combination. Usually the direct lighting is from downlights recessed or semi-recessed in the ceiling and located over counters, displays and selling areas according to the requirements of the particular installation. They are available in a large variety of designs both louvred and with lenses and concentrating or distributing as may be required. The indirect units are often concealed in the tops of fixture and wall cases or may consist of floor pedestals or counter urns. In some cases coves are employed. If this is done lamp sizes should not be less than 100 watts on 25 cycles unless 3 phase, 4 wire circuits are available. Even 100 watt lamps show some degree of flicker especially on high intensity installations. Tests on a cove built in a London store showed no objectionable flicker at working levels using 25 watt lamps on 2 phases of a 3 phase, 4 wire system although it was noticeable on the

ceiling immediately adjacent to the lamps. Turning on the 3rd phase removed even this ceiling flicker. Another interesting installation uses 100 watt lamps with concentrating reflectors at 12 in. centres which direct the light to the ceiling through horizontal louvres in the wall. The walls in this case were built flush with the front of the dress cases leaving a three foot duct. Incidentally the customer installed fans at the ends of these ducts drawing off the heat in summer and forcing it into the store in winter. He reports a considerable decrease in his heating bill.

There is no objection to using standard fixtures in place of reflectors or coves. However, as these may be installed in any store without structural changes, the average merchant appreciates being shown how to take advantage of his structural alterations.

The load possibilities of small display lighting should not be overlooked in preparing layouts. All display cases should have concealed units of at least 40 watts per foot. Recessed spots over display dummies, flush units with both daylight and inside frosted lamps over fitting mirrors etc., all add to the appearance of the store and the completeness and practicability of the lighting. Generally it is best to have lighting performing a useful function rather than a purely decorative one. Luminous signs should never be forgotten in the modern store. Even the smallest can use at least one and they do much to enhance the appearance and atmosphere of the store as well as being of much use in advertising or in directing customers. By louvring the bottom they may perform a duel function by lighting down on counters or displays.

Showcase and shelf lighting depends a great deal on the type of goods displayed. The new fluorescent lamps should not be overlooked for showcase lighting where heat is an important factor such as candy or meat cases. Such small auxiliary installations in a store where no greater immediate sales are possible serve as silent salesmen of the value of better lighting to the owner.

There is great scope for improved window lighting which provides many profitable load possibilities with a very high load factor. One or two storekeepers making improvements in window lighting soon force their neighbours to follow suit. There need be no scruples about encouraging what appears to be a rather invidious practise. Usually those most enthusiastic about good lighting are the individuals who have improved their own lighting and appreciate the improvement in appearance, colour and quality of the goods displayed.

The intensity of lighting recommended will vary with the locality. In downtown London the standard set several years ago was 200 watts per foot for a medium window which has already been adopted by nearly half of the merchants. The use of window lights in daytime to overcome daylight reflection is unknown to the majority of merchants. Although this does not contribute any additional load it sells more kilowatt-

hours and supplies the merchant with a solution for a troublesome problem.

The use of luminous and silhouette signs is increasing, though slowly. The introduction of vitrolux and armourlux, which are translucent coloured structural glasses, should supply an impetus to this field. An entirely new design is possible using mass as well as line and if desired the entire storefront may become a luminous sign.

Indirect lighting is still the best solution to the vast majority of office lighting problems, usually by the use of standard indirect fixtures. Decrease in errors, increased efficiency, less eye strain, the possibility of placing desks regardless of the location of fixtures all appeal to the office manager. It is sometimes necessary to use direct lighting installations where conditions are not favourable for indirect units and for such cases glass enclosing units are generally employed. Where it is necessary to resort to desk lamps to increase local intensities there is a very varied line of suitable desk lamps on the Canadian market to suit practically any requirement. The office workers themselves should not be overlooked when selecting a proper solution. It is surprising the defects a stenographer can find in a unit that has hitherto appeared to lighting specialists as the acme of perfection, if for some reason it does not suit her fancy.

These same factors also apply to factory lighting and the active co-operation of the factory worker is often required to make an installation. A note of warning should be included here, however, to guard against stirring up dissatisfaction amongst employees towards existing lighting conditions. Such dissatisfaction usually does not react finally in favour of the lighting specialist. There is a far greater need for factory lighting than for any other type if present conditions may be considered a yardstick. Unfortunately many manufacturers have just passed through a slack period and have emerged with obsolete plants and still have budgets which are far from lavish. Among the "necessity" manufacturers *e.g.* hosiery, food, shoes, printing etc., who have not felt the pinch of depression so badly, considerable additions have been made. Usually the sales have been for more local lighting of a much higher quality than has been prevalent. Trial installations have convinced superintendents of the benefits of removing glare and increasing intensities. Glassteel diffusers, deep bowls, angle reflectors and silver bowl lamps represent the great majority of factory installations.

Tailored lighting has entered the factory in the form of continuous indirect troughs of various designs. They have found considerable application in hosiery mills, printing plants, laundries etc., for specific applications. They bring the factory worker all the advantages of indirect lighting hitherto confined to the office staff without the necessity of extensive structural changes and redecorating.

For a paper on trends in lighting there has been considerable space

devoted to methods of selling light. In any lighting campaign, to be successful, salesmanship must predominate and trends are decided by the relationship between the salesman and the consumer. Possibly it has been noticed that the words "customer" and "consumer" have recurred frequently. We must not be like the boy who claimed the moon was more useful than the sun because the moon shone at night when it was needed. Although "commercial lighting" blazes brightly across load building horizons its brightness is only the reflected activity of the consumer. The lighting program must be fitted to his needs. His needs cannot be regulated by the lighting program.

# The New 400,000 Pound Compression Testing Machine in the Commission's Laboratories

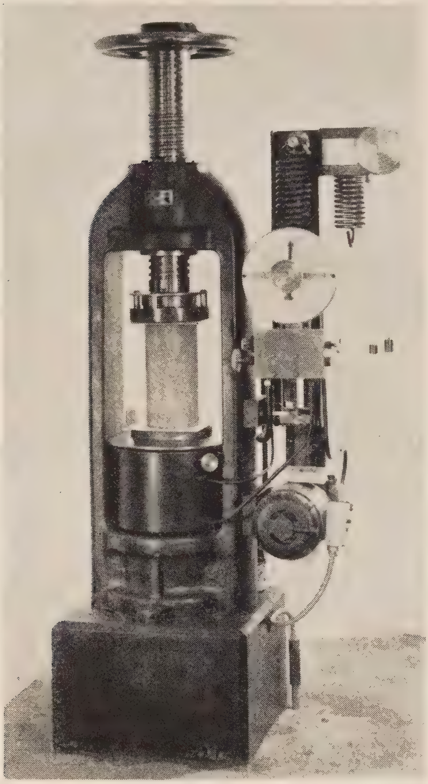
By E. J. Mason, Testing Engineer, H.E.P.C. Laboratories

WITH advances in testing technique and improvements in the quality of various materials, particularly concrete, there has been a need in recent years for testing machines of higher capacity and of greater precision. These developments have also brought about refinements in respect to methods of controlling and maintaining a constant speed of load application during test. To satisfy these demands, the Commission's Laboratories have recently installed a new compression testing machine having sufficient capacity and precision to meet present day requirements for this type of testing.

The machine, supplied by Alfred J. Amsler Co. of Schaffhouse, Switzerland, stands five feet in height, occupies a floor space of about five square feet and weighs approximately 2,000 pounds. It is essentially a large hydraulic press in which the specimen is crushed between a fixed upper bearing plate and a lower plate that rests on the working ram of the machine. Oil is used as the hydraulic medium, the pressure on the ram being applied by a triple piston pump driven by a one-half horsepower electric motor.

The oil pressure on the working ram simultaneously operates an auxiliary piston arranged to deform a calibrated coil spring in proportion to the load being applied. This deformation is transmitted to a pointer which indicates on a graduated dial the total load on the test specimen.

The rate of loading is regulated manually by adjusting a control valve



*Amsler 400,000 Pound Capacity Hydraulic Compression Testing Machine with a Standard Concrete Specimen Set-up for Test.*

placed in the oil line between the pump and the working ram. With this valve the operator can vary the rate of loading to suit his requirements over a range of from 50 to 23,000 pounds per second. To ensure, however, that the load is applied exactly at the speed specified for the material under test, the load indicating dial is equipped with a pacing pointer driven by a mechanical clock through suitable pulleys. The pacing mechanism sets the rate at which the load indicating pointer should travel over the dial if the correct speed of testing is to be maintained. By regulating the control valve so that the travel of the indicating pointer coincides with that of the pacing pointer, the operator causes the load to be applied to the specimen at the required rate throughout the test. When the specimen breaks, another pointer remains at the highest value reached on the dial, thus indicating the maximum load developed during the test.

The machine has a maximum capacity of 400,000 pounds. By inserting interchangeable load measuring springs and dials, however, it can be converted into a unit having a maximum capacity of either 100,000 or 200,000 pounds. This arrangement offers certain advantages in testing lower strength materials.

The accuracy of the machine was checked by dead weights at the manufacturer's plant prior to shipment and on arrival at the Laboratories further calibrations were made. In each case the machine was found to be accurate within a fraction of one percent.

Although the equipment will be used largely for testing masonry materials, it is adaptable to any compression test that can be accommodated by the testing space available. Insofar as concrete is concerned, the maximum capacity is such that it is possible to break a standard specimen having a compressive strength of over 14,000 pounds per square inch. This exceeds by a substantial margin the strength of concretes being used at the present time or that are likely to be developed for some years.

# Psychology and the Day's Work

By Morris S. Viteles, Associate Professor of Psychology, University of Pennsylvania

CONFIDENCE in the machine, widespread among employers during the last century and in the early part of this century, fostered the policy of making human values secondary to machine values. Economy in the use of capital for purchase of machines, careful inspection and replacement of worn-out parts and the husbanding of machine resources, received careful consideration. Dollar-and-cents losses sustained by wasting human resources through over-work, industrial accidents and disease and by the use of incompetent, untrained and unwilling workers were overlooked.

The application of psychology in industry follows from the recognition in more recent years that the development and rational utilization of labor saving mechanical devices must be supplemented by a more complete and effective utilization of human energy, human abilities and of the human will-to-work to ensure the success of the individual industrial plant and the future of our industrial civilization.

In its application in industry, psychology seeks to satisfy two objectives:

The first is to promote the adjustment of the worker—to insure a high degree of satisfaction from his work.

The second is to increase industrial efficiency—to decrease the cost of production, cost of accidents and of other such expense items in the budget of the industrial concern.

Selective adjustment of workers at the time of employment is one of the best ways of promoting the happiness of the workers and of insuring his efficiency and welfare, especially in an organization in which there are many jobs to which he can be fitted. For new workers it is a means of avoiding unnecessary transfer from job to job, from plant to plant and the heartbreaking disappointment which comes from not making good on a job after a trial period of service. To workers already employed on a job, especially in a hazardous occupation, it is comforting to know that the men placed alongside of them, are of such caliber that they will not, by reason of incompetence, contribute further to hazards inherent in the job. From the viewpoint of the management the contribution of scientific selection toward the increase of productive efficiency and toward the reduction of production, accident and allied costs is in itself sufficient justification for the introduction of such procedures.

The selection of able workers is only one field in which psychological methods have been usefully employed. Another field in which extremely important contributions have been made, is that of accident prevention.

The point of view underlying the traditional safety program is that the

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An address delivered to the Royal Canadian Institute, Toronto, February 11, 1939.

chief cause of accidents is "carelessness." However, an analysis by psychological methods shows that the phrase "carelessness" is merely a smoke screen concealing the more fundamental human factors in accident causation.

The chief outcome of the psychological approach in accident prevention is the demonstration that accidents do not distribute themselves by chance, but that they happen frequently to some men and infrequently to others as a logical results of a combination of circumstances. Studies in textile mills, repair shops, rubber factories, electrical supply shops and among drivers of street cars, taxis, trucks and private automobiles have shown the existence in some individuals of a susceptibility to accidents or accident proneness from which others are relatively free. In other words, men who have accidents in one year will continue to have accidents in other years unless appropriate steps are taken to overcome the conditions which make them particularly susceptible to accidents.

This newer outlook on accidents is particularly apparent in the transportation industry, where accidents constitute a particularly serious problem. Street railway companies and taxicab companies have made use of the individual or clinical study of accident-prone drivers as a means of reducing accidents to the minimum. This study includes a complete analysis of the employee's driving record, general work history, operating habits, attitudes, outside interests and activities and other items of personal history which may affect his efficiency as a safe motor vehicle operator. Personnel records, a personal interview, observation of driving habits on the street car or cab are employed in obtaining complete and reliable information on these items. From the survey, conclusions are drawn concerning the causes of the driver's accident proneness.

The character of the treatment prescribed for the operator depends upon the diagnosis. It may take the form of systematic instruction to replace faulty habits or operation where these seem to be involved in the accidents. In other instances medical treatment, discipline, encouragement, or supervisory follow-up may be used in rehabilitating the accident prone employee. Treatment is differential in character. It is based on the recognition that there are many different causes of accidents, that these may be combined in different patterns in different individuals and that the remedy must be adapted to the cause.

The reduction of accidents among operators of private vehicles calls for the application of techniques similar to those which have been used in industry. The first of these calls for adequate training in operation, for all who are allowed the privilege of operating potential mechanisms of death on the public highway. Our highways are cluttered with operators who do not drive safely because they have never been taught how to operate properly.

The same attention and effort must be centered on learning to drive as are given to establishing fundamental skills in a game. There is every reason to believe that very many accidents come simply from the failure to establish habits which are funda-

mental to the safe operation of a car. Here, in my opinion are a few which if properly "set" during the learning period, would do more to reduce the number of accidents than the efforts which we are now putting into browbeating or frightening the driver into operating in conformity with state regulations that often have little bearing on the accident problem.

1. Consistently remaining 25-feet behind the car ahead when driving on the open road.

2. Making certain that there is a clear road ahead and ample room for passing before passing a car.

3. Slightly decreasing speed when being passed by another car.

4. Applying the brake before disengaging the clutch.

5. Braking the car and then coasting slightly ahead before coming to a final stop when followed by another car.

6. Properly signalling at all times.

These are only a few of the fundamental habits frequently neglected by the friend or automobile salesman to whom the new driver usually goes for instruction.

Equally important as the need for training new drivers—both young and mature—is that of restraining experienced drivers who have failed to form safe habits of operation or have developed wrong and unsafe driving practices. Something is being done in this direction by clinics established by courts and under other auspices to do something about drivers who have accidents. This approach to the problem very much resembles the banal and oft-criticized practice of locking the barn after the horse has been stolen. What we need is a program of prevention which will provide drivers with the techniques so successfully used by the transportation industry for the analysis of driving habits and correction of driving defects. Driving clinics should be established and experienced drivers urged to visit these clinics for an analysis of their driving habits, just as they are urged to visit the dentist for prophylactic treatment and to seek a medical examination as a means of avoiding ill health. Examination and treatment in such driving clinics can help to prevent death and injury from an automobile accident in much the same way as dental and physical examinations help to prevent death and suffering from disease.

So much time has been devoted to the highway accident problem—in this address, that little time is left for the discussion of other applications of industrial psychology in what I have called the day's work. In fact, extremely important contributions have been made in many different fields. Let us take for example, the matter of worker's attitude. It is commonly recognized that we must know what the worker thinks—that we must have a complete knowledge and understanding of his attitudes, if industrial strife is to be avoided. Psychology can contribute much toward the substitution of accurate fact for the opinions and hunches upon which dependence is only too frequently placed.

One more illustration may suffice to illustrate the significant findings of industrial psychology in studying the broader aspects of the efficiency and adjustment of man to his day's work. For example, there has recently

been much criticism of the machine age—by those who fear the final outcome of man's glorification of the machine.

Studies by psychologists here and abroad show clearly that much of the blame levelled against work with machines is wrongly directed. They indicate, for example, that machine work, repetitive work at an imposed speed and rhythm, is not invariably accompanied by an overwhelming and depressed feeling of monotony.

There seems to be no universal, deep-seated conflict with an instinct of workmanship. As a matter of fact, there are many who prefer routine work, who like automatized tasks which leave the mind free for other pleasurable activities. There are others, apparently a smaller number, who rebel against uniform, specialized work, but even in their case, adaptation is not so difficult as it is suggested by the protagonists of the "creative" instinct. In general, the most encouraging aspect of psychological studies is their failure to confirm the point of view that the human mind is dulled, emotional maladjustment seriously intensified, or broader social participation hindered by repetitive work. In these respects, the findings of experimental investigation coincide with what is shown by a review of the history of work. Throughout the ages a large proportion of workers has been accustomed to some form of repetitive work. Long before the appearance of machines, many tasks had already become highly standardized and routine in character. The hours and hours of polishing required for the preparation of flint arrow-heads used by the primitive tribes, must have been extremely monotonous work. Hand weaving, with repeated throw of the shuttle from side to side, has in it all of the elements of repetitive work of the Machine Age. The shorter working day and week, the higher standards of living, facilities for employee education and recreation available to the worker in the Machine Age combine to give the worker opportunities for relaxation, self-expression and creative experiences outside of working hours beyond the scope of anything that existed in earlier ages. The problem appears to be largely one of encouraging and educating workers to take advantage of those opportunities. Its solution may involve an attempt to substitute more productive and creative experiences for the automobile ride, the baseball game, the movies, the radio, which at present seem to occupy the spare time and mind of the American worker. It is the development of a program to stimulate such substitution, rather than to the critique of mechanization in industry, that the attention of the social reformer should be directed. And if, in spite of education for the use of leisure, most men and women continue to find adequate satisfaction in the simpler and less creative forms of relaxation, this in itself may be evidence that creative experience is something which today, as in the past, is craved by only a few selected spirits.

THE BULLETIN

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# The National Electric Show

THE Hydro-Electric Power Commission's Sales Promotion Program was launched definitely in Toronto during the week of April 17th, when all of the manufacturers of electrical equipment, jobbers and dealers co-operated with the Toronto Hydro-Electric System and The Hydro-Electric Power Commission in "Electric Demonstration Week."

The outstanding feature of this effort was the National Electric Show which was held in the Maple Leaf Gardens in Toronto for three days, Thursday, Friday and Saturday, April 20th, 21st and 22nd—the first demonstration of its kind in Canada. The "ice surface" of the Gardens was suitably divided into booth spaces and manufacturers of household equipment exhibited all kinds of electrical appliances in this area. The booths were tastefully decorated in Spring colors and ornated by floral decorations. Altogether some 22 companies displayed their wares in 50 fair sized booths.

The feature attraction of the show was a stage presentation entitled "The Cavalcade of Electrical Living," presented by Miss E. Frances Thompson, a world renowned Home Economist. This presentation consisted of a two act performance in which the principal features and advantages of many household appliances were demonstrated in dramatic fashion.

In the centre of the exhibition area there was erected a large band box structure decorated with fluorescent patterns and each evening a dancing act was performed on this band box. By the aid of ultra-violet lighting many very attractive color effects were produced on the decorations and on the dancers.

Stanley St. John's Orchestra contributed to the program, afternoons and evenings, to round out a very enjoyable entertainment.

Jack MacLaren of Radio fame acted as Master of Ceremonies for the entire program.

The Show was opened officially by the Lieutenant-Governor on Thursday

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Vol. XXVI No. 4
April, 1939



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission: to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interested are invited for publication.*

evening, opening ceremonies being broadcast as part of "The Garden of Melody" program. This opening was preceded by an official dinner given in honor of the Lieutenant-Governor and attended by many notables in the electrical industry.

On the evenings a regular stage presentation was given and during these perfomances valuable prizes consisting of ranges, refrigerators, washing machines, mixers and other small appliances were given away by a prize draw conducted by Dr. T. H. Hogg, Chairman of the H.E.P.C. on Thursday evening, by T. R. C. Flint, General Chairman of the Show Executive Committee on Friday evening, and M. J. McHenry, Director of Sales Promotion of the H.E.P.C. on Saturday evening.

During Friday and Saturday mornings and afternoons the Maple Leaf Gardens was open to the public for general view of the exhibition, as during the performance in the evenings it was not possible to have crowds circulating among the exhibits. Then after the performance was over each evening the public were admitted to the exhibition floor until closing time.

It is estimated that from 15,000 to 20,000 people visited the first National Electric Show, and from expressions of opinion which have been heard on all sides the National Electric Show was a very successful venture.

In organizing for the National Electric Show a Central Committee was set up, consisting of members of The Hydro-Electric Power Commission, the Toronto Hydro-Electric System and various electrical manufacturers and jobbers throughout Canada. T. R. C. Flint, of the Toronto Hydro-Electric System and President of the Electric Service League of Toronto was General Chairman of the Show Executive. The Electric Service League acted as co-sponsor of the show; the handling of the details in connection with the putting on of this demonstration was done under the direction of G. W. Austen, Manager of the League. The General Committee was assisted by a number of sub-committees—Program Committee under the Chairmanship of D. C. McKellar, Northern Electric Company; Publicity Committee with A. W. J. Stewart, Toronto Hydro-Electric System as Chairman; Finance Committee, hav-

*Exhibition area, looking towards the stage.*

ing G. J. Mickler, H.E.P.C., Chairman; Decorations Committee guided by G. W. Austen as Chairman, and Lighting Committee under the direction of G. G. Cousins, H.E.P.C. M. J. McHenry acted on all Committees in an advisory capacity.

All of these committees deserve a lot of credit for the manner in which this show was conducted. Special credit is due G. W. Austen, for his untiring efforts as general secretary of all committees.

In order to finance this undertaking the utilities, manufacturers and jobbers co-operating in the venture were classified and each was asked to contribute to the general funds of the Show Committee in order of their responsibility to the industry, and those contributors who wished to display their merchandise in the exhibition were allowed to purchase space according to their requirements. A general admission charge was made to the public at 25c for the evening performances and 10c for admission during the day.

The following list enumerates all of the members of the electrical fraternity who co-operated in the first National Electric Show in Canada:

Amalgamated Electric Corporation.
Brooks Lamp & Shade Co.
xCanadian General Electric Company.
xCanadian Westinghouse Company.
xCoffield Washer Company.
Cables, Conduits & Fittings.
Canada Wire & Cable Co.
Canadian Telephones & Supplies Ltd.
Canadian Triangle Conduit Co. Ltd.
Cansfield Electrical Works.
Continental Electric Co.
Curtis Lighting of Canada.
xT. Eaton Company.
xEllis & Howard.
xElectric Service League.
English Electric Co. of Canada Ltd.
xFlexible Shaft Company Ltd.
xFrigidaire Division, General Motors Sales Corporation.
Federal Wire & Cable Co.

*Official dinner given in honor of the Lieutenant-Governor of the Province of Ontario,*
*The Honourable Albert Matthews, LL.D.*

*Head Table—From Left to Right*

*G. W. Austen—General Secretary, National Electric Show; Controller McNish—City of Toronto; G. D. Leacock—President, Moloney Electric Company; N. S. Braden—Vice-President, Canadian Westinghouse Company Ltd.; Controller Wadsworth—City of Toronto; E. M. Ashworth—General Manager, Toronto Hydro-Electric System; D. C. Durland, President, Canadian General Electric Co. Ltd.; F. D. Tolchard—Secretary, Toronto Board of Trade; Controller Dr. Conboy—City of Toronto; J. Albert Smith—Commissioner, Hydro-Electric Power Commission of Ontario; Lieutenant D. A. Fitzgerald—Aide-de-camp; His Honor the Lieutenant Governor of Ontario; Dr. T. H. Hogg—Chairman, Hydro-Electric Power Commission of Ontario; T. R. C. Flint—Chairman, National Electric Show Committee; Controller Hamilton—City of Toronto; K. A. Christie—Vice-Chairman, Toronto Hydro-Electric System; Paul J. Myler—President, Canadian Westinghouse Company Ltd.; W. C. McBrien—Chairman, Toronto Transportation Commission; F. S. Corrigan—President, General Steel Wares Ltd.; J. J. Ashworth—General Manager, Canadian General Electric Co. Ltd.*

Ferranti Electric Ltd.
Force Electric Products.
General Steel Wares Limited.
xHobart Manufacturing Company, Limited.
Hydro-Electric Power Commission of Ontario.
xIndependent Electric Ltd.
xInternational Steam-Electric Co.
xKelvinator of Canada, Ltd.
James R. Kearney Corporation.
xLang Bros. Specialty Co.
xMasco Company.
xMoffats Limited.
Minneapolis-Honeywell Regulator Co. Ltd.
Moloney Electric Co.
xNorthern Electric Company.
Packard Electric Company.
Powerlite Devices Ltd.
xRenfrew Electric & Refrigerator Co. Ltd.
Sangamo Electric Co.
Service Lamp Co.
xSolex Company.
xSparton of Canada Ltd.
xSuperior Electric Ltd. (Pembroke).
Smith & Stone Ltd.
Superior Electric Supply Co. (Toronto).
N. Slater Co. Ltd.
Toronto Hydro-Electric System.
xTudhope Metal Specialties Co.
John C. Virden Ltd.
xWaring Mixer Company.

The contributors who displayed their merchandise are indicated thus "x" in this list.

A valuable contribution to the success of the Show was a special section of The Globe and Mail devoted to advertising, and editorial material publicizing the event and advertising the equipment on display.

The electrical industry is enthusiastic over the results of this huge undertaking and is hopeful that this will be the beginning of many a National Electric Show.

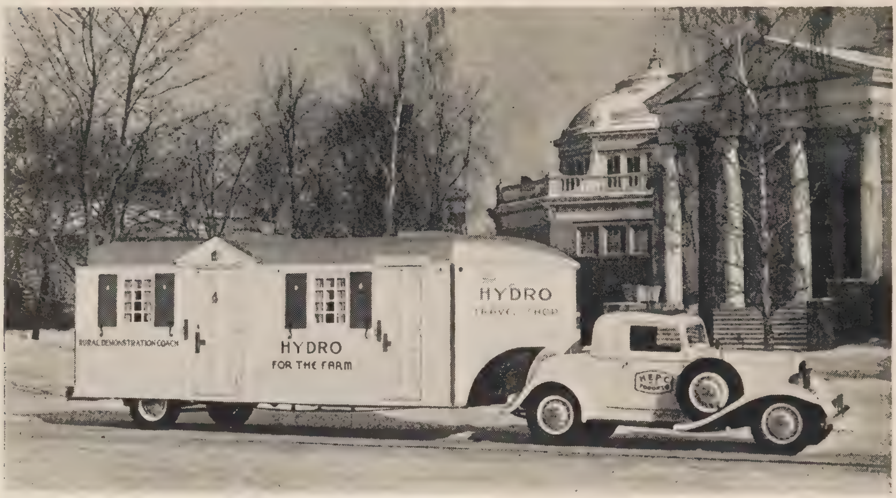
# The Hydro "Travel Shop"

THE Hydro Sales Promotion Department announces the inauguration of a new sales promotion activity for the benefit of rural consumers in the Province of Ontario.

They have placed on the road the Hydro "Travel Shop," which is a showroom on wheels and which will roll out over the highways and the byways carrying the idea of living and farming electrically to all rural Ontario.

The Travel Shop is a motorized trailer unit fully equipped with modern electrical appliances for the home and for the farm, and is manned by a crew of trained salesmen and demonstrators capable of disseminating information on the use of this equipment and on the advantages to be gained thereby.

It is planned to have the Travel Shop move from one rural power district to another on a regular schedule, and as each rural power district is visited a regular program of demonstrations will be held consisting of




*The Hydro Travel Shop.*

cooking schools, farm equipment demonstrations, lectures and so forth. At the same time prospects for electrical equipment will be given information to enable them to decide what is most suited to their requirements,

*Display of household equipment in front end of trailer.*

*Farm and dairy equipment shown in back end.*

also prices and information on where the various makes of equipment can be secured.

The sales crew will also assist dealers and others to demonstrate individual appliances so that Hydro consumers will thoroughly understand their uses.

Another function of the Travel Shop will be to assist smaller municipalities, in which no suitable local organization exists, to conduct cooking schools and demonstrations for the benefit of consumers in these municipalities and to further assist in promoting range campaigns, water heater campaigns and any other activity which it may be the desire to promote locally.

It is also proposed that the Travel Shop visit country fairs, exhibitions and local market places to give Hydro consumers an opportunity to see the latest electrical equipment on the market and to learn how economical it is to make full use of this equipment in their homes, on their farms and elsewhere.

The Travel Shop has already started on its way and an itinerary has been planned for several months in advance. From the reception given to the Travel Shop and the expression of opinion of those who have attended cooking schools and demonstrations there is reason to believe that this will prove a very valuable instrument in promoting the sale and use of electrical equipment among Hydro consumers in the rural districts of the Province of Ontario.

# Chatham Electrical Show

TO demonstrate improvements, new ideas, styles and departures in electrical appliances and their uses, a second annual Electrical Show was held at Chatham on Thursday, Friday and Saturday, April 20th, 21st and 22nd. The first show held last year attracted thousands of visitors and was successful beyond expectations of the sponsors, who were thus encouraged to make this year's event even greater. Eleven Chatham electrical dealers, including the Hydro Shop, pooled their efforts to make the show attractive and interesting and built up a number of exhibits and demonstrations.

The show was held in the Public Utilities warehouse and sub-station and was opened by Fred Biette, Chairman of the Chatham Public Utilities Commission, assisted by Mayor J. J. Zink and Commissioner Charles Austin.

In addition to the exhibits arranged by the Chatham dealers, visitors to the show were given the opportunity for inspecting, for the first time, the Hydro Travel Shop, a trailer truck arranged for rural demonstrations by The Hydro-Electric Power Commission of Ontario.

## Blenheim's New Public Utilities Building

Blenheim Public Utilities Commission has erected a new headquarters building which was officially opened on Tuesday, April 25th.

The building, which is one-storey and is 36 feet wide by 90 feet deep, stands on a lot having a frontage of 52 feet by 210 feet deep, running through to the street in the rear. The front 40 feet is used for office space, consisting of a lobby and display floor, board-room, general office space, vault, billing and stock-room and wash rooms. In the rear 50 feet, are the meter repair room, stock-room, loading platform and truck space. The yard space at the back provides for a driveway and pole storage.

The show windows at the front are of large plate glass, bordered with black and green Vitrolite glass panels. The interior is suitably finished to conform to the purpose of the build-

*A couple of typical booths at the Chatham show.*

ing and the lighting designed to comply with the standards of The Illumination Engineering Society.

The 1939 Blenheim Public Utilities Commission consists of William Neil, Chairman, and Mayor Gordon Knights and David Irving, Commissioners. P. S. Shillington is the Secretary-Treasurer, and C. F. Tumelty, Hydro Superintendent. The Hydro staff operates, in addition to Blenheim Hydro-Electric System, Blenheim Rural Power District, Erieau Hydro-Electric System and Erie Beach Hydro-Electric System.

# A. M. Bowman, Elmira, Honoured

We note with pleasure that A. M. Bowman of Elmira is to be the 1938 recipient of the Fuller Memorial Award presented annually by the American Waterworks Association. The following is an extract from the Convention issue of the Waterworks Information Exchange covering the 19th Annual Convention of the Canadian Section held in Toronto, April 12th to 14th, 1939:

A. M. BOWMAN GETS THE FULLER MEMORIAL AWARD

"The Fuller Memorial Award this year goes to A. M. Bowman, Waterworks Superintendent of Elmira, Ontario. This is only the second award of this kind for the section, and it is presented in recognition of the work of the recipient in the waterworks field.

"This Memorial Award is issued each year by the Parent Association to commemorate the name of one who made a lasting contribution to waterworks, Geo. W. Fuller. It is granted to a member who has demonstrated his skill and aptitude in those activities which made famous the name of the party for whom it has been created. In making the presentation to Mr. Bowman the section is paying tribute to one who has shown efficiency in the operation of a typical waterworks system. While the municipality with which he has been associated is not a large one it is recognized that intricate problems can and do arise in such systems, and are such as to require the best skill of the operator:

"Congratulations to Mr. Bowman are in order."

Mr. Bowman has acted as Waterworks and Hydro Superintendent in Elmira since 1917. His interest in his work has been intense and he has lost no opportunity to improve his knowledge. There is practically no waterworks or electric plant in Eastern Canada or in the Northern States that he has not visited and acquired detailed information in respect thereof. He has been a regular attendant at all Conventions and is well versed in electrical matters as well as waterworks affairs. His conscientious application to his duties has been a great asset to the Elmira Public Utilities Commission. We are pleased that his associates have seen fit to acknowledge his efforts in the waterworks field.

The actual presentation will be made in Atlantic City at the meeting of the Association in June 1939.

# A System of Concrete Control for Scattered Small Jobs, Used by a Large Organization

By R. B. Young and W. Schnarr, Testing Engineers, H.E.P.C. of Ontario

THE Hydro-Electric Power Commission of Ontario was among the first to introduce modern methods for controlling the quality of concrete. As far back as 1919, a system based on the water-cement ratio theory was used in the construction of the High Falls development*; and by 1921, several jobs, totalling nearly three-quarters of a million cubic yards had been completed on which methods of control and inspection very similar to those practised today had been used.

Naturally, on these early jobs, the technical problems were those of the pioneer; i.e., applying new principles to old problems and adapting new procedure to the variety of conditions that arose. During this period, the jobs were relatively large and no thought was given as to whether or not the knowledge and experience being obtained could be used on smaller work. However, as the success of the new practices became assured, this question arose and an attempt was made to solve it. By 1926, several concrete jobs as small as one or two thousand cubic yards had been built using in great part the control technique that had been developed for the larger operations. From this, followed a demand for modified methods that could be used on even the smallest concrete job and so instructions, applicable where the quantity of concrete to be placed did not exceed 500 cubic yards, were prepared for the use of superintendents, foremen and engineers responsible for this class of work.

These instructions were not immediately accepted by the men for whom they were prepared, and it has required not a little effort to convince them that they are reasonable and in the interest of the job; but that condition has gradually passed and now the methods have almost unanimous acceptance and are in use on all jobs for which they are applicable.

About two years ago it was decided to revise and amplify these instructions in the light of the experience gained in their use during the previous ten years. The resulting document, which forms the latter part of this paper, is offered as a contribution to the Institute's efforts of bettering ordinary concrete.

These instructions are not submitted as an answer to the problem of controlling the quality of concrete on

*Seven Years of Experience with Job Control of the Quality of Concrete—By R. B. Young. Proceedings A.C.I. 1926, Vol. 22, p. 79.

Presented to the American Concrete Institute at New York on March 2, 1939.

the small job. They are neither complete nor comprehensive and anyone reading them will find many things omitted that probably he would feel should be included but, in spite of their very obvious omissions, they have worked well and filled a need in the work of the organization for which they were prepared, and that is the best answer the authors can make to possible criticisms.

It is obvious that these instructions have been written with a particular organization in mind. Because of this, it will be desirable to outline the conditions under which they have functioned so satisfactorily.

In the first place, the Commission does most of its own construction and this work is centralized in one department. It maintains also, a large laboratory, a section of which is equipped to make investigations required in selecting materials and testing concrete. The laboratory also carries out inspection of all kinds including that of concrete construction and so is staffed with men competent to deal with any problem that arises in connection with concrete work.

The operations of the Commission are of some magnitude and its construction work offers regular employment to a large staff. The total number of men engaged in this class of work varies of course with its activities but there is always a sufficient number employed to insure a continuity in field operations, which facilitates the enforcement of instructions such as are here described. Periodically, there are newcomers to train, but many of the foremen and others get their jobs by promotion and, therefore, are already familiar with the Commission's way of doing work.

To facilitate the training of the field forces and promote uniform methods, the Commission annually holds a foremen's convention to which is sent the more responsible field men that can be spared from jobs in progress. These men are from various lines of work; in fact, all of the trades that go to make up ordinary construction are represented. Some have daily contact with concrete work, some only occasionally, but because of the diversity of the work that they may be called upon to do and the probability that anyone of them may have to supervise jobs involving each of the different trades, all receive instruction in the concreting methods of the Commission.

With this introduction, let us consider briefly, the few simple requirements set out in the appended Instruction:

In the first place, it is intended both as a specification for the making of concrete and as an explanation of why it should be done as described. Both the specification and explanatory matter have been combined in one document because it is felt that the men will more willingly follow instructions if they understand the reason for them. To separate the "must" from the "why", all mandatory clauses are distinguished from explanatory clauses by the use of a distinctive type face.

The general specifications of the Commission require that any concrete exposed to the weather in whole or in part, shall have a minimum compressive strength at 28 days of 3,000 lb.

per sq. in. For work coming within these instructions, this, in effect, is all concrete placed; thus only one class has to be considered, which helps to simplify the work.

For concrete where durability is the controlling factor, the practice of the Commission is to specify a definite minimum cement content. For average work having a coarse aggregate graded to not over a 2-inch maximum and subject to rigid inspection, this is usually set at from five to five and one-half sacks per cubic yard. For small jobs, which receive no inspection and which usually have to use approximate methods for measuring the aggregates, the minimum cement content is usually set at 6½ sacks per cubic yard.* This may seem high but it is more important on this class of work to make certain that the concrete is durable than to effect small economies in the use of cement. On an average small job, the cost of the extra cement thus used will seldom exceed $100.00, a sum which would not pay for many repairs, if they became necessary later by reason of poor concrete.

Throughout the instructions, special emphasis is placed on the necessity for keeping the total water in the concrete within the specified limits. To bring this out more pointedly, repeated reference is made to the water contained by the aggregate and the necessity of correcting therefor. This has been done deliberately because experience has shown a general tendency amongst concrete men to forget this important point.

*The Canadian sack of cement weighs 87½ lb. gross.

Since the average small job has no facilities for testing the moisture content of aggregates, an empirical method must be used for its determination and so the instructions under Corrections for Moisture in Aggregates have been adopted. Experience over ten years has shown that this simple method is satisfactory and seldom presents any difficulty in operation.

Proportions are given both in weights and volumes but the latter are generally used in practice. It will be noted that no reference is made to the usual dry rodded volumes, the proportions being stated in terms of aggregates containing natural moisture, i.e., in the condition which they will be used on the job. This practice introduces no important error, yet it avoids the necessity for correcting the proportions for the bulking effects of moisture. In most cases, the aggregates are tested prior to use and the proportions are set by the laboratory but where, for any reason, this is not done, the proportions specified in the Instructions are used. As the Commission's practice on all concrete operations of any size is to measure all materials by weight, cognizance is taken of weight proportions for the benefit of those men who are used to working with these units.

It will be noticed that the Instructions permit those in charge to modify the basic mix as conditions on the job may require. This is done to provide for variations in the grading of the aggregate and for any changes in workability that may be necessary in different sections of the work. The practice may be questioned by some as putting too much authority in the

hands of the foremen or others, but since the specification contains a minimum cement content, a maximum water-cement ratio, a consistency requirement and the provision that "the amount of sand shall not be less than ⅔ of the volume of the coarse aggregate or more than equal to it", the quality of the concrete is safeguarded and no trouble has so far resulted.

The inclusion in the instructions of an actual example for the calculation of batch quantities needs little comment other than to point out that it has proven useful and also helps to emphasize that corrections must be made for the moisture contained in the aggregates.

The clauses covering materials are simple because the acceptance or rejection of both cement and aggregates rests with the Commission's laboratory. An exception to this is made in the case of purchases of small quantities of cement.

One of the most frequent and troublesome questions that arise is the use of cement that has become caked from storage. Some of the Commission's work is carried out at inaccessible locations and cement has to be transported and stored months ahead of actual concreting. In spite of every precaution, caking of cement occurs and much study has been given to the usefulness of cement in this condition. Tests have shown repeatedly that caked cement that will pass the simple test given in the Instructions will meet standard specifications and make good concrete.

Because of their importance, considerable attention is given to the question of aggregates. Pit run aggregates are forbidden although much of the work has to be done in areas where commercially produced aggregates are not available and the use of unscreened materials would be a great convenience. At one time this was permitted, subject to certain conditions, but even with rigid restrictions imposed, the practice was found to be unsatisfactory and for the last few years, has been discontinued.

No great difficulty has been experienced in getting suitable coarse aggregates; therefore, little reference has been made to them but there has been much confusion as to what constitutes a good concrete sand and so this information has been included, together with an excerpt from the Commission's Aggregate Specification, which is used where sand is to be purchased from local dealers.

The latter may interest some of our readers because it differs in important particulars from accepted standard specifications. It places a rather high minimum limit upon the amount passing the No. 48 sieve, specifying twelve instead of the usual five percent; it permits five percent passing the No. 100 sieve, and it definitely limits the amounts that may fall between the No. 8 and 28 or the No. 14 and 48 sieves. These requirements are based on experience with water and earth retaining structures built with aggregates that would not meet this specification. Through the years, the concrete in these structures has shown a lack of durability that could be traced to porosity of the concrete brought about by the use of sands either lacking in fine material or containing too large a percentage of par-

ticles of approximately one size. Deficiencies of this type can only be compensated for in part by the use of additional cement and therefore for concrete that must be durable and watertight we are more and more insisting on the use of well-graded sands.

The sampling of aggregates is considered at some length because it is a frequent and very important duty which has to be performed by the field men.

Admixtures are treated very briefly. In general, they are forbidden but on occasion, with the permission of the engineer, use is made of calcium chloride as a hardening agent and when so used the amount to be added to the mix is definitely limited to two pounds per sack of cement.

Measurement is also treated briefly. Much experience with measurement by struck volumes has demonstrated that where conscientiously done, it gives quite satisfactory results. There has been no difficulty in getting this provision carried out, for the officials responsible for construction, because of their experience with weight proportioning on large jobs, realize the necessity for accurate measurements. The men on the job also, once they have used struck volumes, appreciate the advantages of having a uniform concrete to handle and place, and are willing to take the extra trouble necessary to obtain it.

Due to the fact that the mixing equipment furnished any job is entirely under the control of the Commission, no specifications are required for this part of the concreting operations except to point out that the batch must be turned over for a full minute and one-half.

Curing follows standard practice but some comment is necessary regarding the treatment of concrete in freezing weather. No chemicals are allowed to be used as an anti-freeze. This is already forbidden under Admixtures but is mentioned again because of the persistent propaganda maintained in some quarters, recommending calcium chloride and other salts as an anti-freeze. The idea underlying such practice is very attractive but it is a poor prop to lean on in even moderately cold weather.

The other clauses under the heading Precautions in Freezing Weather, represent in essence the Commission's practice in cold weather concreting; namely, to keep the concrete mixes at reasonable temperatures and to give them protection as soon as possible after being placed rather than to put them in hot. Finally, it is specified that "Suitable means shall be provided for maintaining all parts of the concrete at a temperature of at least 50 deg. fahr., for not less than 72 hours after placing"; i.e., the concrete just within the forms rather than the enclosure built without the forms is to be kept to the required temperature.

The section on surface finishes is somewhat longer in proportion than other parts of the Instructions. There are two reasons for this:—first, a great deal of difficulty has been experienced in the past because of poor finishing, and second, it is desired that there shall be as much uniformity as possible in the finish of the Commission's concrete. No apology is offered for the methods adopted; there are

other ways of obtaining satisfactory surfaces, but these have worked well and that is their justification.

The final section of the Instructions deals with the testing of concrete and follows standard practice. They are included because samples of concrete are regularly required from all but the very smallest of jobs and the sampling and moulding of the specimens have to be done by the field men.

In conclusion, a word of tribute to the many men who are building the Commission's small concrete structures. In the ten years in which an attempt has been made to introduce adaptations of modern concrete methods onto the small job, the quality of the work has greatly improved. Whereas, 2,000 lb. per sq. in. concrete was the rule ten years ago, concrete made today will often run as high as 5,000 lb. per sq. in. with no increase in the quantity of cement used. The workmanship has improved to a point where honeycomb, fill planes and other evidences of carelessness are practically non-existent and the general excellence of the concrete is evident to even the most inexpert observer. All in all, the engineers of the Commission are well satisfied with the results that are being obtained.

* * * *

## INSTRUCTION FOR CONCRETE ON JOBS OF LESS THAN 500 CUBIC YARDS

### Quality

Unless otherwise specified, *all concrete shall have a minimum compressive strength of 3,000 lb. per sq. in., at 28 days. It shall contain a minimum of 6½ sacks of cement per cubic yard and the maximum amount of water used shall not exceed 5 Imperial gallons for each sack of cement in the mix.* (Water-cement ratio by weight of 0.57).

### Water-Cement Ratio

The strength and durability of concrete is adversely affected by the use of any water in excess of that actually needed to hydrate the cement. *Therefore the maximum amount of water specified shall not be exceeded* and if circumstances require a more plastic mix than the proportions as given permit, *cement as well as water shall be added to the batch* to maintain the quantity of water used per sack of cement (water-cement ratio).

The maximum water is the total amount entering the mix and *shall include the surface water carried by the aggregates, which must be deducted from the total in determining the water to be added to the batch.*

### Corrections for Moisture in Aggregate

Whenever the moisture content is not determined accurately by test, *the surface water that is carried by fine and coarse aggregates shall be assumed to be as follows:*

| *Aggregate* | *Condition of Aggregate* | *Imperial gal. per cu. ft.* |
|---|---|---|
| Fine aggregate | Damp | ⅛ |
| do | Moderately wet | ½ |
| do | Wet | ¾ |
| Coarse aggregate | Damp | No correction |
| do | Wet | ¼ |

Note: An Imperial gallon of water weighs ten pounds.

These quantities, multiplied by the cubic feet of sand and crushed stone or gravel in the batch will give the quantity of water *that must be deducted in determining the amount of water to be added to the mix.*

### PROPORTIONS, GENERAL

Proportions may be given in terms of dry weights or damp volumes but for jobs coming within this specification, the latter will usually be used.

*Proportions by Volume*

For average well-graded aggregates, containing their natural moisture, the proportions by volume will be approximately:

| | |
|---|---|
| Cement | 1 sack |
| Sand | 2.20 cu. ft. |
| Coarse Aggregate | 3.00 cu. ft. |
| Water Maximum | 5 gal. |

*Proportions by Weight*

For average well-graded aggregates free from moisture, the proportions by weight will be approximately:

| | |
|---|---|
| *Cement | 1 |
| Sand | 2.25 |
| Coarse Aggregate | 3.25 |
| Water Maximum | 5 gal. |

per sack of cement.

Where proportions are given by weight but measurement on the job is by volume, it will be necessary to convert the weights specified into equivalent volumes of the damp aggregates as used.

For average conditions and materials, *a unit weight of 90 lb. per cu. ft. for sand, (either moist or wet), and 95 lb. per cu. ft. for gravel or crushed stone (either dry or damp) shall be used in the calculation of batch quantities* unless actual tests have been made to determine the units weights on the job or other weights have been specified by the Laboratories.

### EXAMPLE OF CALCULATION OF BATCH QUANTITIES

A typical calculation showing how to convert weight proportions to batch volumes and also how to make corrections for moisture in the aggregates is given here as a guide.

Assume that 3,000 lb. concrete is required and a two-bag batch is wanted. Let the proportions specified be: 1: 2¼: 3¼ by weight and the aggregate available be sand and gravel, both damp.

The weight of the different materials for a two-sack mix will be therefore:

*Cement—2 sacks, i.e.,
$2 \times 87\frac{1}{2} = 175$ lb.
Sand —$2\frac{1}{4} \times 2 \times 87\frac{1}{2} = 394$ lb.
Gravel—$3\frac{1}{4} \times 2 \times 87\frac{1}{2} = 570$ lb.

Converting these to volumes, using the unit weights specified in the preceding section, gives:

Volume of sand, $394 \div 90 =$ 4.4 cu. ft.

Volume of gravel, $570 \div 95 =$ 6.0 cu. ft.

The maximum quantity of water is specified to be 5 gallons per sack; hence, for a two-sack batch, this will be:

$$2 \times 5 = 10 \text{ gallons}$$

From this must be deducted the amount of water contaned in the sand. (If the gravel was wet the water in it would also have to be deducted. DAMP SAND CONTAINS 1/3 or 0.33 GAL. PER CU. FT. AND THE SAND IN THE BATCH WILL THEREFORE CONTAIN $4.4 \times 0.33 = 1.45$ GAL. As no correction has to be made for the small

*The gross weight of a sack of cement in Canada is 87½ lb. and is assumed to contain a cubic foot of cement.

amount of moisture contained in damp gravel, the water to be added to the batch will therefore be:

$10 - 1.45 = 8.55$ or $8\frac{1}{2}$ gallons.

The actual volumes to be used are therefore:

| | |
|---|---|
| Cement | 2 sacks |
| Sand | 4.4 cu. ft. |
| Gravel | 6.0 cu. ft. |
| Water | 8.5 gallons |

If the proportions are specified by volume, it is only necessary to multiply them by the number of sacks of cement to be used in the batch, correcting for moisture contained in the aggregates in the manner just described, to obtain the quantities to be measured.

### Correcting the Mix to Meet Job Conditions

If, in use, the proportions given produce too harsh a concrete, the workability may be improved by increasing the quantity of sand and correspondingly decreasing the quantity of coarse aggregates, except that the amount of sand shall not be less than 2/3 of the volume of the coarse aggregate or more than equal to it.

If the mixes are too wet, the quantity of aggregate may be increased provided the mixer capacity will permit; if not, both the cement and water should be decreased by whatever amount is necessary to obtain the proper consistency. Vice versa, if the mixes are found to be too dry, the quantities of aggregates may be decreased or the cement and water both increased.

### Consistency or Workability

No hard and fast rule can be given for determining the consistency of the mix for it depends on the type of work and must be decided on the job. Generally speaking, *the mix shall be as dry as circumstances permit, yet it shall be plastic and workable so that it will place and finish well, but it shall never be so wet that it will segregate in handling.* Since any increase in the wetness of a mix, increases the amount of cement and therefore the cost necessary to meet the quality provisions of these specifications, *mixes that are wetter than absolutely necessary shall not be used.*

### Cement

*Shipments or purchases of cement in excess of 50 sacks shall be tested by the Laboratories and shall not be used until reported by them to be satisfactory.*

Cement that has been caked in storage is still usable if, when pressed between the thumb and fingers, it readily powders. *Cement that does not meet this test shall not be used until its quality has been checked by the Laboratories and permission granted.*

### Water

*Water for concrete shall be clean and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances. Potable water is satisfactory; other water shall be subject to approval by the Laboratories before use.*

### Aggregates, General

*The engineers shall be advised of the source of aggregate to be used on each job. Preferably, an established source of aggregate shall be chosen, but where this is not possible or where the Commission has never used aggregate from the source in*

*question, samples of all aggregates which it is desired to use, shall be taken and submitted to the Laboratories for approval.*

*Aggregates shall be separated into sand and coarse aggregate before being used. No pit or crusher run materials will be permitted.*

Where screened aggregates are not available and screening has to be done on the job, a suitable screen for separating the fine and coarse aggregate would be a commercial ½ in. or its equivalent, mounted on a 2½ ft. by 4 ft. frame sloped to a batter of 8 in 12.

In selecting sand* it should be remembered that fine sand requires more cement to produce concrete of a specified quality, and very fine sand will not be permitted. A very coarse sand gives poor finishes and concrete that does not weather well.

### Sampling Aggregates

It is essential that samples be representative of the material taken, as it is on these samples that the suitability of the supply is judged.

*If a deposit is worked as a bank or pit and has an open face, the sample shall be taken by channeling the open face. Care shall be taken to eliminate any over-burden or stripping at the top or any that has fallen along the face.*

*In sampling from belts, trucks or stockpiles, numerous samples shall be taken at various intervals or at various places about the pile.*

A systematic collection of samples, should when assembled, contain a correct proportion of each size and be representative of the larger mass. When the accumulated samples have been taken, it will be necessary to reduce the total to approximately 75 lb. This may be accomplished by quartering as follows:

Mix all samples together while still moist.

Pile in the shape of a cone.

Spread by drawing the cone from the centre outward with a shovel.

Divide the sample into four quarters.

Remove the two opposite quarters.

Remix the remainder.

Continue this procedure until the sample is the size required.

*Each sample shall be shipped in a secure box or bag, and contain the following information:*

Source of supply.

Quantity available.

Distance to nearest point where material is to be used.

Sampled by.

Where the material is to be used.

### Admixtures

*No materials other than portland cement, aggregate, water and reinforcement shall be used in any concrete unless authorized by the Engineer.*

Calcium chloride, when permitted by the engineer, is to be used only for accelerating the hardening of the concrete and no reliance is to be placed on it as a protection against

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**Purchases of sand shall conform to the following requirements:*

*Grading*—Fine aggregate shall be graded from fine to coarse within the following limits:

| | *Percent Passing* |
|---|---|
| No. 4 sieve | —95. |
| No. 48 sieve | —Not more than 30 and not less than 12. |
| No. 100 sieve | —Not more than 5. |
| Weight removed by decantation | —Not more than 3. |

Not more than 75 percent by weight of the fine aggregate shall lie between sieves Nos. 8 and 28, nor between sieves Nos. 14 and 48.

freezing. *It shall not be used in excess of two pounds per sack of cement in the batch.*

### MEASUREMENT

*Cement can be batched in whole or half sacks without further measurement. If other than a half sack of cement is required, it must be measured in calibrated boxes.*

*All fine and coarse aggregate shall be measured* separately in suitable boxes provided with adequate handles so as to insure that the specified quantities are in each batch. Where larger quantities of concrete are placed, struck buggies and wheelbarrows may be used.

*Water shall be measured in calibrated tanks or barrels by an approved method.*

### MIXING

*Mixing shall be done in an approved batch mixer and the mixing time shall not be less than 1½ minutes after all ingredients are in the mixer.*

### PLACING

*The surface on which concrete is to be placed shall be clean, free from debris, laitance and surface water. The surface shall be saturated with water for some hours previous to placing the concrete. Where the concrete is placed on rock or other concrete, dry cement or cement paste shall be brushed into the surface for bonding. The first batch placed shall be mortar, obtained by omitting the coarse aggregate from the specified mix and reducing the water as required. Following the mortar, the concrete shall be deposited continuously and as rapidly as practicable from bottom to top, except where otherwise directed by the Engineer.*

*The concrete shall be deposited in the forms as nearly as practicable in its final position.* The plastic surface should be approximately horizontal and any dropping, chuting or method of placing that segregates the concrete should not be used.

*The concrete shall be compacted during and after depositing by tramping, vibration, or with suitable tools. The concrete shall be thoroughly worked around embedded fixtures, and into all parts of the forms.* Light spading of the concrete next to the form will prevent honeycombing and make the surface smoother.

Compaction must be thorough, but the concrete should not be overworked as this is detrimental.

### CURING

*All freshly placed concrete shall be protected from the weather. As soon as the concrete has hardened sufficiently to prevent damage thereby it shall be kept continuously wet by sprinkling or otherwise for at least seven days.* Moist sand is very satisfactory as a curing agent.

### PRECAUTIONS IN FREEZING WEATHER

*All aggregates shall be thawed free from frost and ice before being used.*

*Salt or other materials shall not be mixed with the concrete for the purpose of preventing freezing.*

*Concrete placed at a temperature lower than 40 deg. fahr., shall have a temperature of not less than 60 deg. fahr., nor greater than 90 deg. fahr.*

*Suitable means shall be provided for maintaining all parts of the concrete at a temperature of at least 50*

*deg. fahr., for not less than 72 hours after placing.*

SURFACE FINISHES

*All surfaces to be finished shall be screeded as indicated on the plan. Following this a wooden float shall be used to depress all stones and the concrete allowed to harden until floating does not bring water to the surface. At this time the whole surface shall be given a final wood floating. Steel trowels shall not be used except where specified. Proper curing shall follow for seven days.*

*The face forms shall be removed as soon as practicable, all fins or other projections shall be carefully removed, and any voids or damaged places shall be immediately saturated with water, and filled with a mixture of the same composition as that used in the surface, and allowed to set.*

*The surfaces to be finished shall then be wetted and rubbed with carborundum brick, or other abrasive, without applying any cement or other coating, until even and smooth. When this has been done, the grout or mulch which has collected shall be thoroughly washed off. For surfaces not specified to be painted, the surface shall again be wetted and rubbed until a small accumulation of fine grained paste is produced. This paste shall not be removed, but shall be carefully spread with a moist whitewash brush, to form a uniform, very thin coating upon the surface of the concrete.*

CONCRETE TESTS

*Concrete test cylinders shall be made on all jobs of 50 cu. yd. or over, and on smaller jobs when specified.*

*One test shall be made for each 50 cu. yd. of concrete placed. Three cylinders shall be considered a test. Concrete for tests shall be collected from numerous batches, remixed only enough to produce uniformity and then moulded.*

*When making test specimens, each mould shall be one-third filled and then rodded 25 times with a 3/8 in. bullet pointed rod. This operation shall be repeated until the cylinder is filled. The top of the cylinder shall be screeded off and allowed to settle but no further finishing shall be done. Stone over 1½ inches in size shall not be put in the mould.*

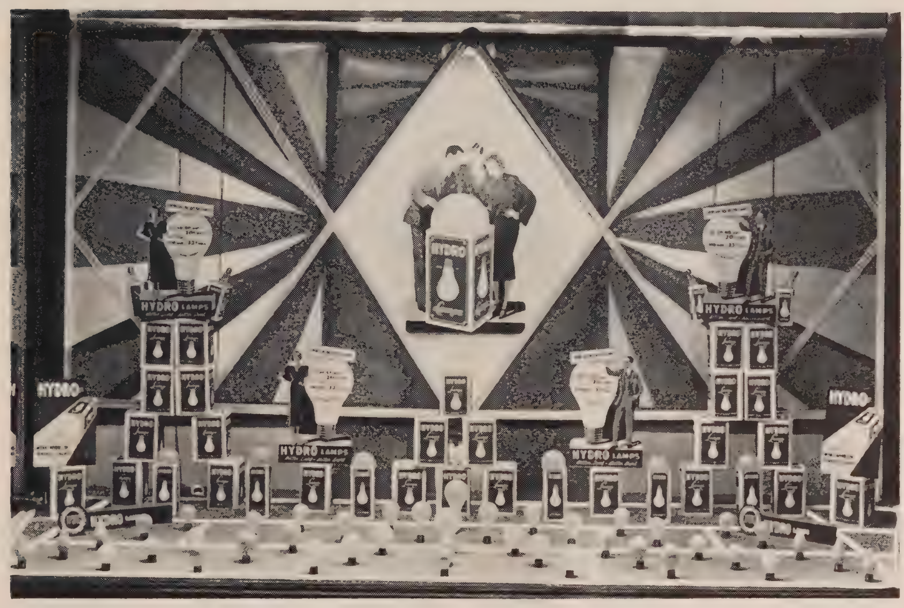
*Test cylinders shall be stored in damp sand where the temperature shall not fall outside the range of 60 deg. fahr. to 75 deg. fahr. All test cylinders shall be sent into the Laboratories by express in time for the 7-day test.*

The Laboratories will supply the field with moulds and test form reports as requested.

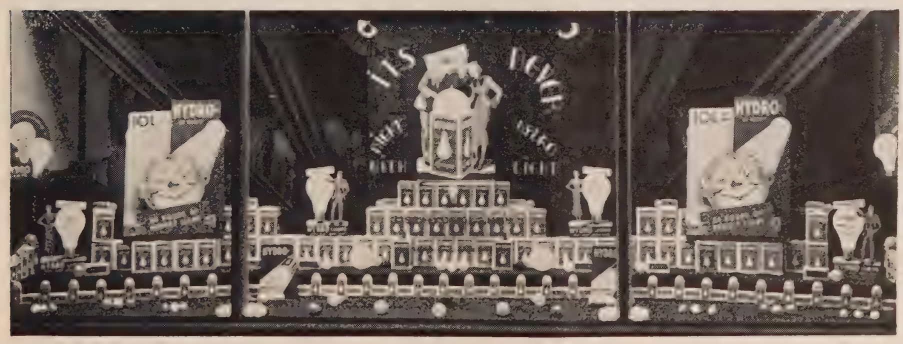
# Hydro Lamp Window Dressing Contest Awards

## Class 3

## Hydro Shops located in the larger towns



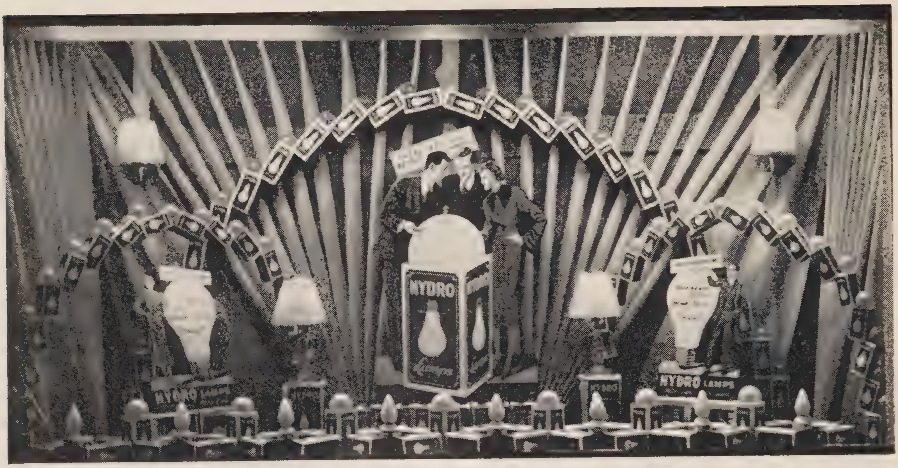

*First Prize, Class 3, Ingersoll Public Utilities Commission.*




*Second Prize, Class 3, Picton Public Utilities Commission.*

## Class 4

# Hydro Shops located in smaller towns




*Tie First Prize, Class 4, Stamford Township Public Utilities Commission.*


*Tie First Prize, Class 4, Forest Public Utilities Commission.*

# Sales Promotion

## A Presentation of the Sales Promotion Programme of the Hydro-Electric Power Commission of Ontario

**By M. J. McHenry, Director, Assisted by other Members of the Sales Promotion Department, H.E.P.C. of Ontario, G. W. Hague, Vice-President, MacLaren Advertising Company, Limited, Toronto, and J. W. Welch, Director of Sales Promotion, Edison General Electric Company, Chicago**

*(Continued from March)*

*Mr. G. G. Cousins*

The Commission has been furnishing lighting service, as many of you know, for a good many years. It started, I would say, about twenty years ago, and came as a natural outgrowth of the work of our illumination laboratories.

We received occasional requests for advice on lighting. These grew until it became necessary to engage an engineer on such work for his entire time.

All of the work that has been done previous to last summer, came to us without solicitation on our part. It is quite evident then, that when there is a large demand for lighting service, that there is a large field for organized lighting promotion.

Last spring, a lighting section was organized for a more extensive campaign. We placed four men in the field, and this service was announced throughout the province, and for a time, the requests came faster than we could comply with them, with the result, I am afraid, many of you were disappointed in not getting prompt service.

We are now organized for a more extensive campain. Mr. McHenry has shown how the districts are divided with men allotted to each district, so they will be conveniently situated at any time.

I think you are all familiar with the old Chinese adage that one picture is worth a thousand words. The literal interpretation of that might be that the science of sight is a thousand times better than speech.

We have not stopped at pictures, although pictures are used a great deal. We put on a demonstration, and I think I can safely say one demonstration is better than a thousand pictures.

Proper demonstration material enables us to put up an installation of lighting in a store, both interior and also show-window. The wiring is of a temporary nature. It can be assembled on the spot, and put up in one to three hours, depending upon local conditions.

So far, we have requested that these be connected ahead of the service meter so that the merchant in whose store these demonstrations are placed, will feel free to use them. In fact, we tell them that it will not cost a cent, and they can use the

lighting in a way that otherwise they would not be able to.

The demonstration load will be in the neighbourhood of 3,600 or 4,000 watts. We believe it is valuable, and is of great assistance to this campaign and the service in general, to have such power that is used in a week, supplied free. It enables us to present the story of lighting in a way that we couldn't do otherwise.

We are asking the municipalities to advertise this service when we send men into a town, and we have found that when the men are started, they are looked for from place to place.

We would like the local municipal systems to give our men access to the building records of a number of prospects. By that means, they can study what the merchants have been paying for power, and how much has been used, and what their hours of use are. We can then go to a merchant with valuable information with regard to the merchant's use of power, and with a better starting point from which to promote the use of better lighting, the greater use of power for longer hours. In a great many cases when we tell the merchant how much it will cost to operate this lighting load for a greater number of hours, they show no hesitation in adopting our recommendation.

We equip our men with meters and other instruments with which to make a survey of lighting conditions in any kind of premises, whether a store, a factory, office or other place where light might be used. They make a survey of the conditions and where plans can be made, sketches are sent to the office, and new recommendations and plans are prepared and forwarded, a copy being sent to the local Hydro manager so that he knows what we are recommending to his consumers.

Now, what have we been accomplishing by this service? During the months of November and December, we have issued 93 reports. The original load in the places surveyed amounted to 263 kilowatts and the load recommended by our recommendations amounted to over 950 kilowatts. That is a ratio of three and a half times.

We are not foisting on the merchant a means to sell power. Service is the keynote of this work. Our men are instructed to render the best service they can, whether it involves increased lighting load or otherwise. We are rendering a service, and the increased load naturally follows.

This service has been very gratefully received. In many instances, the merchants who are approached and who have had the lighting situation explained, have asked why this service wasn't available before. In many cases, before our men leave town, the merchants who have received our recommendations have already started to carry them out. In one instance, a merchant wouldn't allow our men to take down the demonstration equipment, but had it permanently installed.

Lighting is a most valuable load for the use of power. The executives of the power companies in the United States who have been operating

lighting service departments for a number of years, admit frankly that it was the lighting load that carried them through the depression.

With the men that we now have on our staff, we cannot cover the whole province at once. We have to lay out our work so that men can move from place to place, in a more or less logical sequence. We will have at least one man available to answer any calls for immediate service.

In a town or city the size of St. Thomas, it takes about six man-weeks to make a thorough survey. We follow that up a month or so later by a week of follow-up work with the merchants and others, to obtain fullest results.

If any of you have requests for lighting advice in your district, and you require immediate service, please write in and let us know. We will endeavour to comply with your request.

*Mr. McHenry*

I am sure that Mr. Cousins will not object if I add to his complete outline of the work involved, the thought that the lighting section has been established for the benefit of the municipal systems. We are anxious to make surveys of commercial establishments in as many towns and cities as possible. Therefore, I suggest to Hydro managers and commissioners, that they forward us their requests for such surveys, and we will endeavour to arrange a schedule which will take care of each municipality as quickly as possible.

In our plans for this year, there is one particularly interesting campaign on which we have not touched as yet. We are fortunate in having with us this afternoon, the Vice-President of our Advertising Agency, the MacLaren Advertising Company Ltd. It is my privilege to introduce Mr. George Hague to you, and to ask him to present to you, one of the outstanding campaigns which has been planned.

*Mr. G. W. Hague*

Today I have the privilege of describing one of the most vital and interesting promotional projects ever undertaken by a public utility on this continent — Electric Demonstration Week.

Specific weeks set aside to emphasize aspects of our community life have become increasingly popular in recent years. The result is that we have an Educational Week, and an Apple Week, and a host of other kinds of weeks. And so, with the growth of sales-consciousness in the agressive and up-to-date electrical and power industry in Ontario, the question naturally arises "Why not an Electric Demonstration Week?"

I will tell you as briefly as I can the reasons underlying the decision to hold an electric demonstration week. It is designed to make at one time and one place, everybody electrically conscious, and to provide the entering wedge that will open the way to more intensive merchandising in the electrical industry in the key cities and towns of Ontario.

Now, who participates in this campaign and provides this entering wedge? The answer is—everybody in the electrical industry. The Hydro-Electric Power Commission of

Ontario, the local Municipal Hydro Commission, all local dealers, manufacturers and jobbers of every type of electrical equipment will co-operate. And added impetus will be given the project by the daily newspapers of Ontario, in the form of essential publicity and editorial support.

For the most efficient and effective operation of the plan, we have zoned the province creating five zones, the proposal being that we will run five consecutive demonstration weeks—one in each zone.

The city of Toronto, on account of its size, is the only place where the activity will be confined to one municipality at one time. Toronto constitutes one whole zone by itself. In the other four zones, five and sometimes six of these demonstration weeks will be conducted simultaneously in as many municipalities.

There are some twenty five key cities and towns in Ontario where there are daily newspapers, and as a daily newspaper is a most important feature in this campaign, we are planning to use them in each case as the centre of the activity. We want demonstration weeks to run in every important municipality; but the cities where there are daily newspapers, are recognized as the key centres of their communities.

In discussing the plans for the demonstration week in Toronto, I might almost be excused for using the word "stupendous." On account of the very magnitude of our Toronto project, it would be impossible to duplicate it in every one of the cities on our schedule. However, I can promise you definitely that the effect of this activity in Toronto will overflow into the trade channels of the Province as a whole, and will be felt in every corner of Ontario. It will be something that for vital and irresistible public appeal, will undoubtedly rival even the National Motor Show.

The functions of the Hydro-Electric Power Commission of Ontario in this series of demonstration weeks are manifold. First of all, the Commission has undertaken to organize the entire activity—something which would have been totally impossible without the leadership and direction offered by the recently organized Sales Promotion Department, headed by Mr. Morris J. McHenry. To his men in the field will fall the duty of going out and organizing locally in each municipality, bringing together the local Hydro and the local dealer, and assembling them with the manufacturers and the salesmen,—and in fact everybody interested in the electrical industry—and welding them into one well organized body to put over Demonstration Week in each particular locality.

Next, the Hydro-Electric Power Commission of Ontario is going to advertise—is going out to buy space in the daily press, so that these weeks will be established in the public mind as having the official support and approval of the governing body of Ontario's publicly-owned power system.

A tremendous volume of supplementary local advertising is assured from the industry, which will also advertise in the press at the same time. This combined volume of ad-

vertising will be more than sufficient to ensure positively the editorial support of each newspaper for the campaign.

The extent to which the Commission will attempt to pass on the benefits of the Campaign to the dealer is aptly illustrated in the heading on one of these Commission advertisements. It reads as follows: "Join the Parade to Your Electrical Dealer. Electric Demonstration Week Begins Today in Your Home Town. Your Chance to Win a Prize." Time forbids me to go any more fully at this moment into the advertisements themselves, but I can assure you that they represent the highest form of scientific selling.

But that is not all that the Hydro Commission is contributing to the success of Electric Demonstration Week. It will supply prepared promotional material at the point of sale. For every local dealer who wishes to buy space in his local newspapers; buy radio "spot announcements" or secure window displays, banners, or other material, the Hydro will have an adequate supply of the necessary ads, cuts, suggested program "spots" and other aids. Furthermore, the Commission stands ready to assist every municipality with advice on how to secure the support of women's organizations, schools, service clubs and similar bodies.

Let me not give the impression, however, that these weeks will build up to a climax, and then "let down" suddenly. We must be—and are—prepared to carry on and to continue to reap the benefits of the campaign long after the last window display has been removed and the last banner taken down from the streets.

There is one other aspect of the promotional campaign which we regard as of vital importance to its success. It is a contest which will be, in effect, the final hook to lure people into the dealers' stores. We are going to make it as simple as possible—perhaps something like this: "All you have to do is to go to your local electrical dealer or Hydro shop, get a form, and write out in less than ten words a slogan descriptive of electrical living, and you will be eligible for such-and-such prizes." There may be some who will say immediately "What is the sense of that? A woman walks into my store, gets a form and walks out." To them I say: "You don't know anything about women. There is not a woman in the world who walks into an electrical store—if that store is properly arranged as to exhibits and merchandise—and then just walks out. Average ordinary female curiousity will make sure she gets some impression of what is going on in there, and what is on sale."

I need not go into full detail on this type of contest. It is all laid down in a book prepared by the Sales Promotion Department, and will be explained to you all by men from this department who will call on you.

You may ask "What is the local Hydro Commission supposed to do in this Campaign?" They will be expected to organize, to advertise, where possible to demonstrate, and to offer special terms and other inducements to buy during that week.

The local Hydro Commission *should assume local leadership and be prepared to carry on.*

As for the local dealers, I have indicated already that they will be expected to organize, to advertise, to display, to demonstrate and to co-operate in every possible way.

I can assure you that support will not be lacking from the manufacturers' and jobbers. They have already been approached, and I can say without exception, they have given the stamp of their approval to the plans for Electric Demonstration Week.

I know one manufacturer who, upon hearing of the plan, immediately set about increasing his sales. First of all, he "bumped up" his output quotas, and said, "I am going out to get my share."

The manufacturers are being asked to advertise in their local press, featuring special sales promotion activity, and combining sales, contests and special offers.

Further support, I need hardly say, has been guaranteed by the daily newspapers of the Province. We know positively that they will co-operate, for we have sounded them out. They would have to be short-sighted indeed, to withhold their support, for they know full well that through this province-wide activity, they are going to get a volume of business that they have never had before. They know further, that they are going to get increased lineage from national advertisers who are going to spend their advertising dollars where they get the best returns, and therefore, they are concentrating their efforts with those papers which are supporting Electric Demonstration Week.

In each zone and in each town, while the week is in progress, there, should be special street lighting, street parades, mass meeting, club activities and other types of effort all designed to push this activity to the limit. And underlying the whole program will be a slogan which cannot fail to strike home in every municipality. It is—"Better Living Comes to Town with Electric Demonstration Week, and is Here to Stay."

Gentlemen, I can still hear somebody say, "Well, what of it?" It sounds like a considerable amount of ballyhoo to me, and I can even hear somebody using the old-fashioned word "baloney!"

Well, you know the story of the newspaper boy who was selling his papers and making an awful noise on the street corner, and a dear old lady came up to him and said, "My little boy, you are making far too much noise." He said, "Lady, you don't know nothing about selling newspapers. You have got to yell like hell." We have something to sell. and we have to yell like hell.

Somebody may ask, "Why are you putting all this effort in one week? Why are you taking 4,000 lines of newspaper space and putting it in a newspaper in my city, in this city or that city in a space of say, ten days?"

Well, Gentlemen, I have found in my travels that one of the easiest ways to answer that question is this. I don't know what you fellows think about the automotive industry, but

there is one thing you cannot deny. They are exceedingly smart merchandisers. They have even been known to lift us out of a depression.

Now, if you would just for one second take a look at the hundreds of thousands of dollars that those fellows will pour into one week, when they put on a National Automobile Show, you will get something of the idea of what we are trying to accomplish. I don't say it is perfect. But it is something. We are doing it because we want to make a noise. We want to do something spectacular because before we get through, we want every man, woman and child in the Province of Ontario to be very much aware that a bomb has gone off underneath the electrical industry.

I say that without apology to anybody. You fellows right here have it within your grasp, and I say this advisedly, to do more to *permanently*—to permanently settle this ghastly problem of unemployment than all the Legislatures in the British Empire. You can't settle the problem of unemployment by relief grants, by loans, by public work programs. How can you settle it? As far as I know, there is only one way you possibly can settle it. That is by promoting industry. And how can you promote industry without promoting sales? And how can you create sales without creating desire, and that's where advertising and sales promotion come in.

Now, you fellows have the means to advertise and promote the sale of electric servants. I venture to say there isn't a local Hydro Commission represented here which hasn't a sizeable bank roll. Beyond a normal reserve, what good is it in the bank? It is no trick to keep money in the bank once you have made it. The wise thing to do is make your money work for the people of your community.

And so I repeat that in promoting industry you are really doing a valuable service to your community and the people of this province as a whole. Although I am a servant of the Hydro-Electric Power Commission of Ontario, I am not on its payroll. You understand that. So for a moment, I would like to speak simply as one who has been associated very closely with the electrical industry in the province for more than twenty years. I would like to feel that I am speaking for the entire industry when I pay what I think is a fitting tribute to those fellows who, already burdened with the details of other work, still found themselves able to carry the responsibility of the very successful load-building campaigns which have been carried in the past five years. I refer, of course, to Mr. R. T. Jeffery and his staff of municipal engineers, and I would like to especially mention one—George Mickler.

Now, what shall I say about this new Sales Promotion Department, with whom it is our privilege to work. I hardly know what to say. I can only say this. We are proud to work with them.

They ask nothing from you in the way of praise or patronage. They ask only one thing, and I plead with you this afternoon, as common-sense business men, to give them that one thing that they ask. They ask your

co-operation. They ask your moral support.

Let me tell you truthfully that Mr. McHenry and his staff are honestly and sincerely trying to do a big thing —a big thing for Hydro, a big thing for the industry, a big thing for the people of the Province of Ontario.

*Mr. McHenry*

On your behalf, as well as expressing my own thoughts, I thank Mr. Hague very sincerely for his splendid outline of this particularly interesting campaign. We hope that every Hydro system will undertake to co-operate in this particular effort, and will undertake the local leadership in organization in its own municipality.

It is not easy to give a complete outline of the year's program in sales promotion. We have endeavoured to present to you the highlights of the work which has been planned. More detailed information will be supplied shortly by means of bulletins and publications, and through the efforts of the staff of the Sales Promotion Department in the field, who will be glad to consult with you, and to co-operate and assist in every way that they can.

I believe that you will agree with me that it is not possible for an outstanding job to be done entirely by the staff of the Hydro-Electric Power Commission. Neither is it possible for such a piece of work to be carried out by the individual municipalities alone but it is possible if we have a genuine co-operative operation. Such co-operation should include not only the utility, but should take into regard as well, the municipalities and retail outlets of the industry. I can assure you that the manufacturing section of the industry has already expressed itelf as very keen, and that it will render a high type of co-operation, to all concerned. If we work together for the common good, there will be no question but that the results will be satisfactory. In united effort there is strength. We solicit your active co-operation, and offer our assistance to the greatest possible extent.

It was hoped that we would be able to have certain demonstrations this afternoon, particularly on commercial lighting and commercial cooking. Unfortunately, the time element does not permit these, but we have been fortunate in having with us an authority in the Commercial Cooking field, and I now ask Mr. W. R. Harmer, our Industrial Specialist to introduce him to you.

*Mr. W. R. Harmer*

Gentlemen, we know that the commercial and industrial customers in Ontario present a very fertile field in which we can develop a real load, and for a few minutes this afternoon, we are going to try to show some methods by which this can be carried out, and the benefits to us of carrying out this program.

In this connection, we are very fortunate in being able to present to you Mr. Jack Welsh of the Edison General Electric Company, of Chicago. Mr. Welsh is Director of Sales Promotion for the Commercial Cooking Division of the Edison General Electric Company. He is a member of the Planning Committee on the Commercial Cooking Council of America, and he

has worked with the electrical utilities for the past ten years in the promotion and development of their commercial cooking load. He is bringing with him a wealth of information this afternoon on the value and type of sales promotion in the commercial customers' market. I am now going to call on Mr. Jack Welsh.

*Mr. J. W. Welsh*

In some ten years' experience in the promotion and development of commercial cooking load with electrical utilities, and as a member of the Planning Committee of the Commercial Cooking Council many facts on the subject of heavy duty electric cooking equipment have been brought to our attention.

In briefly reviewing the market, many of us do not realize the full extent of this market for commercial cooking equipment, or what it can mean in actual load. Today, one meal out of every three served on the North American continent is served in a commercial, industrial or institutional food service establishment. So let us consider the value of this cooking load to the utility.

Commercial cooking load has the following characteristics:

(a) High Load Factor—ranging from 35 per cent to as high as 70 per cent.

(b) High Power Factor—a straight resistant heating load with unity power factor makes this very advantageous to the utility from an operating point of view.

(c) Good Diversity—peak demands of commercial cooking load do not occur at the time of the system peak demand.

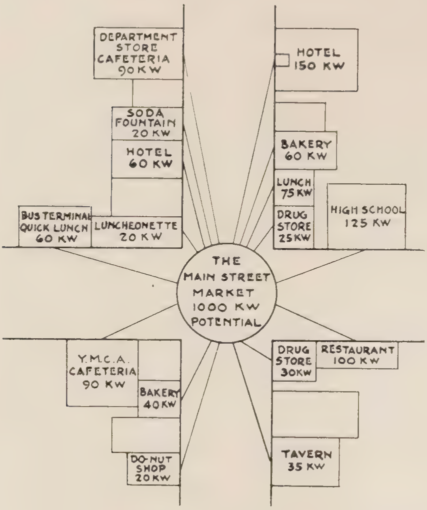
(d) Central Location—the load is on Main Street, where feeder facilities are adequate to carry on the additional load.

Now, let us look into the consumption of commercial electric cooking equipment. Tests made over a period of years have shown that an average of 1,500 kw-hr. per year is consumed per kw. connected. During 1938, one manufacturer of commercial cooking equipment was responsible for the sale of 2,000 kw. in Canada; this represents an approximate usage of 3,000,000 kw-hr. per year. In Toronto alone, 1,000 kw. were added during 1938, from which can be expected a return of 1,500,000 kw-hr. per year. This gives us an idea of the possibilities of commercial cooking as a load builder.

In Ontario, there are many prospects for this commercial cooking load. They exist in every town and every hamlet in the country. They line Main street (see chart). One out of every ten of your commercial customers has some sort of commercial food service. Each one of these is a prospect for some item of commercial electric cooking.

All you have to do is look down the main street of your town. Don't just look at the obvious hotel and restaurants, but include the drug store soda fountain, the lunch counters, the roadstands on your highways, the local hospital, the country home for the aged, the county jail, and many others.

Bearing in mind the average of




1,500 kw-hr. per year for each kw. connected, let us make a comparison with something of which we are all familiar—the domestic electric range load. You can readily see that if one kw. of commercial electric cooking load returned 1,500 kw-hr., then one kw. is equivalent to a domestic range as a load builder. Most utilities have appreciated the value of domestic range load, and have constructed campaigns to increase this load. Having that in mind, we would point out that each commercial cooking kitchen can easily be sold one electric deep fat fry kettle, having an average load of 7 kw., and selling for approximately $165.00, which is equivalent to 7 domestic ranges in kw-hr. The commercial cooking load is therefore entitled to sales promotion efforts equal to those conducted on domestic range load.

On checking the equipment available for use in the commercial kitchen, we find that electrical manufacturers have equipment for every operation that is carried out in any food service establishment. With the rates for commercial cooking prevalent in Ontario, it will surprise you to know that for only *ONE CENT* you can,

Grill 107 sandwiches
or
Fry 70 eggs
or
Fry 90 slices of bacon
or
Brew 60 cups of coffee
or
Toast 112 slices of bread
or
Bake 35 waffles.

In addition to these low operating costs, the electric cooking equipment assures automatic temperature control which gives properly cooked foods with minimum wastage.

In summing up, we might refer to the old adage that the proof of the pudding is in the eating. The new Ontario Hospital now under construction at St. Thomas, Ontario, which we might say is in the centre of the natural gas area, is completely equipped with electrical cooking equipment. This one institution is in itself a good sized town. It will have a capacity of some three thousand inmates and staff, which will be served three meals a day, a total of two hundred and seventy thousand meals per month. The decision for this installation was based on the fact that when considering all factors, electrical equipment has the lowest cost over a period of years.

# THE BULLETIN

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*Entrance of the Hydro Administration Building decorated for Their Majesties' visit.*

MAY, 1939

# Some Mutual Problems

## A Brief Discussion of Annual Adjustment Accounts, Load Conditions and Sales Promotional Efforts, the Water Heater Question, New Legislation, the Proposed Windsor-Sarnia Line, and Municipal Interdependence

By Dr. T. H. Hogg, Chairman, The Hydro-Electric Power Commission of Ontario

As time goes on I have the pleasure of meeting new groups within the framework of the Ontario Municipal Electric Association. This is my first opportunity of meeting the representatives of District No. 8 and of discussing some of our mutual problems. I am very happy indeed to have this opportunity to be here today.

Of the various items of business which concern the Ontario Municipal Electric Association and which are of interest to this branch of it, I propose to deal today with only a few. Questions arising out of the thirteenth bill, some comments on load conditions and sales promotional efforts, a few remarks on the water heater question and new legislation, a reference to the Windsor-Sarnia line and the question of municipal interdependence will, I think, suffice.

### The "Thirteenth Bill"

The subject I want to speak about first may not be of as much concern in your district as in some other districts of the Niagara system, but it is something which affects you all and, I think, is one in which you all take an interest. I refer to what is commonly termed "the thirteenth bill." As a matter of fact I have been given to understand that your executive would welcome some comment from me with regard to it.

More often than not the term thirteenth bill is a misnomer, inasmuch as it is usually a credit. I need not enlarge upon the fact that in reality it is an annual adjustment account by means of which your total annual payments are brought into agreement with the computed annual cost of your service. Last year every one of the thirty-eight municipalities in District No. 8 received an annual adjustment credit; the smallest credit of $27.45 went to St. Clair Beach and the largest of $57,673.96 to Windsor.

Naturally the effect of a large thirteenth debit or credit may be a little disturbing, especially when its magnitude is unexpected. Any difference between the estimated interim rates and the actual power costs must be concentrated into a single thirteenth payment at the year end, if the difference is substantial, the payment must therefore appear quite large. The Commission recognizes that a stable cost of power is a thing greatly to be

An address before District No. 8 of The Ontario Municipal Electric Association at Chatham, Thursday, May 11, 1939.

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*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission: to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interested are invited for publication.*

desired; as I have explained a number of times lately it is the function of the rate stabilization fund to iron out marked variations in the cost of *system* power.

But whether the cost of power which municipalities must pay each year is stable or whether, on the other hand, it varies, it is evidently desirable from your point of view that the interim rates should approximate the actual cost as closely as possible so as to spread the great bulk of that cost over twelve equal annual payments. Here then is a difficulty which should not be overlooked. It is the difficulty in accurately estimating the cost of power a year in advance owing to variations which occur from year to year. These variations are due to (1) increases or decreases in the cost of production and distribution, including generation, purchase, transformation, transmission, etc. and (2) variable increases or even decreases in load, in other words variations in the extent to which available resources are fully and profitably used.

This effect of increases and decreases in the cost of available resources and facilities and of changes in load demand is felt upon a system-wide scale which affects every cost customer and it is also felt on lesser scales in varying degrees down to only a small group or even a single customer. For example, changes in the lump sum cost of generation and purchase of power and changes in the total primary demand affect all customers, while changes in the cost of a transmission line or a distributing station, or changes in the load carried by a line or station may affect only one customer.

It is much easier to estimate one year in advance what the lump sum cost of power resources and transmission and distribution facilities will be, than it is to estimate the effect of changes in the system load or the load of any individual municipality upon the per horsepower cost; in other words, uncertainty as to what the loads will be constitutes the greatest element of inaccuracy in estimating the interim rates that will closely approximate actual costs.

On the Niagara system, during the last few years, variations in both these elements, that is in the lump

sum cost of power and in the extent to which power resources were utilized to supply profitable loads, have been more than usually great. The agreements under which a final settlement of the Quebec power issue were made had an important bearing on cost. In order to effect this important settlement it was necessary for the Commission to accept definite obligations to take and pay for increasing quantities of Quebec power for a number of years. Fortunately the increases that remain to be taken during the next few years are not large. Added to this, the uncertainty of industrial conditions has undoubtedly had a dampening and perhaps somewhat erratic effect upon load growth. Now, returning to the question of interim rates, you will recall that on November 1, 1936, the interim rate to practically all municipalities in the Niagara system was reduced by an amount of $2.50 per horsepower per year; again on August 1, 1937 a further reduction of $2.00 per horsepower per year was made. Bearing in mind the increase in system power commitments and the fact that load increases have not been sufficient to fully utilize the additional quantities of power thus made available, it is not surprising that following these two virtually flat reductions in interim rates, the revenue from certain municipalities has not been sufficient to meet the actual cost of serving them. As a result, it was necessary to render thirteenth debits to 23 Niagara municipalities for the year ending October 31, 1938, while 152 municipalities received credits.

As some of these debits were comparatively large it is only natural that the municipalities which received them should indicate a desire—as they have actually done—to be billed on a basis which more nearly approximates actual cost and eliminates so far as possible substantial thirteenth debits. As a first step in this direction the Commission proposes to increase the monthly interim rates to seventeen municipalities—none of them in this district.

Had graded reductions in interim rates been made instead of the two flat-rate cuts totalling $4.50 per horsepower, there would have been no occasion for any substantial thirteenth debits. Furthermore the question of substantial thirteenth credits would also have received attention and even these would largely have been averted except perhaps where capital projects pending in the near future might be likely to increase costs.

It is important to bear in mind that interim rates and any changes therein have no effect whatever upon the total annual payments for power by any municipality. Each municipality must pay its actual annual cost. The advantage of adjusting interim rates lies entirely in spreading the annual cost more evenly over twelve monthly bills and leaving a smaller and comparatively insignificant sum to be taken care of by the thirteenth account.

In this connection it is interesting to note that so far as any trend in future power costs to municipalities is concerned, it should be downward rather than upward, in consequence of a more complete utilization of available resources to supply primary power demands.

### Load Conditions

I have already mentioned the difficulty of forecasting the trend of power demands. This year, despite the effect of an industrial recession which was prevalent last year and which does not yet appear to have run its full course, and in spite of the rather strained international situation, the load of the Commission's Niagara system has already shown a very satisfactory increase.

The primary load on the Niagara system, for instance, showed an increase last month of 7.4 per cent. over April last year, the total load on the system increased 14.8 per cent., and the total kilowatt-hours consumed by the system increased 12.6 per cent.

However, the real criterion of healthy load growth on the Niagara system, as I pointed out at your winter convention, is given by the total load demand of your co-operative municipal systems. The load in the Niagara system may be divided broadly into two parts: 80 per cent. of the primary load represents the load supplied to the municipal utilities and rural districts, whilst the other 20 per cent. is supplied to large industrial customers, chiefly electro-metallurgical and electro-chemical loads. These large industrial customers are very sensitive to international conditions, but the municipal and rural loads are more stable and are more truly indicative of our own economic conditions.

In the year 1934, the Niagara high tension municipal load increased 4.0 per cent. over the previous year; in 1935 it increased 1.9 per cent; in 1936—7.5 per cent.; in 1937—8.6 per cent.; last year it increased 6.2 per cent.; and this year, according to present indications, it is likely to grow at about the same rate as during last year.

### Sales Promotional Efforts

In order to stimulate and increase the municipal loads, including the rural loads, which are the real backbone of the co-operative system, the Commission, encouraged by your Association, has increased its promotional efforts.

As you well know, the Commission has operated a Sales Department for some time. Several years ago, at the request of the municipalities, the Commission undertook to provide a Hydro lamp of high quality, and of such characteristics as to be most suitable for use in Ontario. The Sales Department has handled on behalf of the municipalities the distribution of the Hydro 1,500-hour lamp with such success that almost every municipality uses these long life lamps for street lighting purposes, and they are sold extensively to consumers by every Hydro shop.

This Sales Department has also been active in the promotion of the use of electrical equipment in the rural districts, and, under its jurisdiction, has arranged financial loans to farmers for the installation of wiring and equipment under The Rural Power Distribution Loans Act and the Hydro Range Financing Plan.

You will remember how about six years ago when the flat rate water-heater was developed the Sales Department also played a prominent part in organizing and carrying out the plan of campaign, and how in following years it organized and conducted

electric range campaigns, supplying advertising material, newspaper cuts, window displays and other publicity aids, together with an allowance to dealers of $3.00 per new range installed.

During the past four years, the Commission has been active in promoting better lighting for homes and commercial institutions. Its Sales Department has trained men and women to demonstrate and lecture on Better Lighting, and lighting specialists have been sent to municipalities to help carry on this work. Last year a small lighting group was initiated to undertake demonstrations and surveys of stores, offices and factories; their work has been of great value in promoting lighting load.

With this useful beginning as a background, the Commission concluded that it could render an even more valuable service to municipalities and users of Hydro power by extending and systematizing its sales promotional effort throughout the Province. This extension and intensification of effort was made with the approval of the municipalities, and early in the fall of 1938 the Sales Department was renamed the Sales Promotion Department and placed under the direction of Mr. M. J. McHenry.

Under the new plan of operation, in addition to a somewhat extended campaign of advertising, a group of experts were placed in the field to assist the Hydro municipalities to secure full advantage of general and local advertising and all round promotional effort.

In the latter part of November, the promotional plans of this department, both as to field work and advertising, were placed before the Merchandising Committee of the Association of Municipal Electrical Utilities. At that meeting, the Merchandising Committee membership was augmented by the inclusion of representatives from most of the major municipalities in the Niagara and Eastern systems. A full presentation of plans of the Sales Promotion Department was made, and these plans were endorsed by the meeting, with the recommendation that they be presented in some detail at the convention of the Association in the early part of February, 1939. Such a presentation of the programme of the Sales Promotion Department was made at the Toronto convention on February 8th, at a joint meeting of the O.M.E.A. and the A.M.E.U.

It is not possible for a detailed account of the work of the Sales Promotion Department to be given at this time, but I would like you to bear in mind that the cost of the new Sales Promotion effort is not entirely a new charge to the Commission. For many years a considerable portion of the total cost has been incurred for work such as I have described; in addition, many of the operations, such as the distribution of Hydro lamps and the supplying of equipment for municipalities, carried out then and now, have been self sustaining. Actually these new services of a Sales Promotion Department have been provided at a relatively low cost.

The work of this new department now under way, is showing evidence of being very helpful and very valuable to the Commission and to the municipal systems. Considerable suc-

cess has been met with in the promotion of domestic uses of electricity, and in the improvement of commercial lighting, and it is particularly encouraging to note the enthusiastic co-operation received from the Hydro municipalities, and from the manufacturing and distributing sections of the electrical industry.

A notable instance of co-operation was afforded by the large National Electric Show staged by the industry in Toronto to introduce the idea of a National Electric Week. The manufacturers and jobbers together undertook to carry 85 per cent. of the direct cost of the show, while the Toronto Hydro-Electric System and the Commission each carried only 7.5 per cent. Moreover, owing to the large attendance, the show showed a small surplus.

### Water Heaters

I do not know whether or not the executive of the O.M.E.A. has informed you that the long standing water heater problem has been settled. The Commission has agreed to rebate 50 per cent. of the installed cost of flat rate water heaters for installations made prior to October 31, 1936.

The problem had its origin many years ago. The Hydro flat rate water heater was first developed as a load builder in 1932, when it was arranged that the cost of the heaters would be paid out of reserves. Later it was decided that the cost of the heaters would be included in the cost of power and the municipalities were billed accordingly. The municipalities objected to this charge and eventually it was arranged that each municipality would thereafter pay for the cost of its own water heaters, but the question of paying for the original heaters, installed before October 31, 1936, was not disposed of.

The settlement just made, whereby the Commission rebates 50 per cent. of the cost of the original 24,000 water heaters out of the contingency funds, at a total cost of about half a million dollars, was proposed by the Ontario Municipal Electric Association and agreed to by all those municipalities which installed the original heaters.

### New Legislation

At the session of the Legislature recently concluded, certain helpful legislation was enacted at the request of the Commission. The bills dealt with the Guelph Railway, Rural Bonus, and the Power Commission Act.

The Guelph Railway Act, 1939, authorizes the Commission to transfer to the City of Guelph the street railway in that city. It also contains the charter powers under which the City will operate the railway and provides for the creation of a Guelph Transportation Commission to manage the business.

The Rural Hydro-Electric Distribution Act providing for 50 per cent. bonus on certain rural lines was amended to clarify the meaning and meet the needs of present-day rural distribution. Formerly the bonus was limited to the capital cost of constructing primary transmission lines and cables, service transformers and meters and secondary lines on the highway. Henceforward, the cost of acquiring land may be included because in some locations we have to keep off the highway. Further, the works for which bonus may be ob-

tained have been defined so as to conform to the definition in the Power Commission Act and include items used in present practice.

With regard to the rate stabilization fund, this Commission fully concurs in your suggestion that power to transfer surplusses or credits of municipalities or rural power districts for other uses be eliminated. This has been accomplished by amendments to the Power Commission Act deleting from Section 12, clause (c) of subsection 1 and also subsection 2.

Section 71 of the Power Commission Act dealing with rural power districts has been simplified by subdividing it into subsections. The Commission may now acquire lands as well as construct works. This will cover the case where it is necessary or cheaper to keep off the highway and build over private land. The signing of consumer contracts by the Township Clerk is declared sufficient. On behalf of the Township the Commission will now be able to exercise all the powers it could exercise on its own behalf under Part I; for example, it will be able to expropriate land when this drastic step is the only course that will adequately protect the interests of rural customers.

Through amendments to sections 76, 77 and 78, the Commission is enabled to extend the benefits of rural service to Northern Ontario as it has done elsewhere.

### The Windsor-Sarnia Line

For a number of years both this Commission and the municipalities' commissions of Windsor, Sarnia and Chatham have given thought to the economic feasibility of additional transmission facilities for their service. This question has recently been brought forward again by resolutions from both the Windsor and Sarnia commissions requesting that this Commission proceed with the construction of additional line capacity to these two municipalities. Studies of load growth and of the operating performance of the existing lines serving the Windsor and Sarnia areas have been made. As a result of these studies the Commission's engineers report that the most economical line to construct would be a steel-tower, single-circuit, steel-reinforced aluminum line from St. Thomas to a point north of Thamesville, and from thence to Windsor. At Thamesville a tap line would be constructed at a later date to Sarnia. The estimated cost of the proposed St. Thomas-Windsor line is approximately one million dollars, with approximately an additional $300,000 for the Sarnia tap-line, and this new capital investment would naturally increase the cost of power to these districts.

Based on an increase of 5 per cent. per annum of the loads in the district, with the full programme completed, the additional power cost per horsepower would be approximately as follows: *(See Table I)*

If these districts are prepared to accept these increases in the cost of power, and are also prepared to help promote a growth in load which will tend to reduce cost as quickly as possible, the Commission is prepared to construct this additional line.

### Municipal Interdependence

To you, gentlemen, and to any close student of Hydro affairs, the evolution of this co-operative undertaking not only has many interesting aspects

TABLE I

Additional Power Cost Attributable to New Lines

| Year | Chatham (Kent) | Windsor (Essex) | Sarnia (St. Clair) |
|---|---|---|---|
| 1939 | $0.80 | $1.53 | $1.58 |
| 1940 | 0.68 | 1.31 | 1.24 |
| 1941 | 0.60 | 1.17 | 1.03 |
| 1942 | 0.54 | 1.03 | 0.77 |
| 1943 | 0.47 | 0.89 | 0.68 |
| 1944 | 0.40 | 0.77 | 0.49 |
| 1945 | 0.33 | 0.65 | 0.31 |
| 1946 | 0.28 | 0.53 | 0.16 |
| 1947 | 0.23 | 0.42 | 0.01 |
| 1948 | 0.18 | 0.31 | ........ |
| 1949 | 0.14 | 0.21 | ........ |
| 1950 | 0.09 | 0.12 | ........ |
| 1951 | 0.04 | 0.03 | ........ |
| 1952 | ........ | ........ | ........ |

but is of vital import. Growth has been the dominant note and where there is growth there is change. In our case there have been many changes of far-reaching consequence.

Hydro municipalities have required more and more power; to meet their demands it has been necessary for the Commission to invest more and more capital and to undertake other long-term commitments on behalf of each group of municipalities, and on behalf of each municipality, pro rata, according to its need. While the original principle of community of interest remains in essence unaltered, this progressive enlargement under which each municipality assumes additional obligations from time to time, according to its own needs, alters and extends the responsibility of each municipality. This precludes the possibility of interpreting the mutual obligations between the municipalities and the Commission in any narrow sense as to quantity or time or of restricting their force and effect to the very limited scope of the Hydro enterprise envisaged by its founders.

For example, the contract with the original Niagara municipalities was based upon purchase contracts under which the Commission secured 100,000 horsepower from the Ontario Power Company and the assumption that only such capital investments as might be necessary to distribute that power would be made. This quantity of power was very soon exhausted; therefore it became absolutely necessary for the Commission to secure very substantial additional quantities of power as time went on, partly through generation and partly through purchase. These additional quantities of power have now become so large as to dwarf the commitments which were the basis of the original enterprise and the original contract.

It soon became apparent that the contractual foundation of the co-operative undertaking which was quite adequate for its limited initial scope was not sufficient to provide adequate safeguards as successive substantial enlargements took place. In order to properly take care of the individual and collective interests of the municipalities, it became necessary to alter and extend their obligations. This was done by legislative enactments which provided that each municipality should assume its proportionate share not only of the original capital outlays but of all additional capital outlays and all additional long-term commitments of any nature; at the same time the term of repayment of capital outlays was extended from thirty years to forty

years. Thus, in effect, the acts provided that each municipality would become responsible for its share of the cost of all financial commitments for at least forty years after any such commitments were made.

I thought it might be of interest to you to reflect on this continuing feature of our co-operative enterprise which is essential to its extensive growth and which arises out of the necessity for successive expenditures on behalf of each system and each municipality. It is also well to remember the interdependence of the individual municipalities comprising each system and to bear in mind the nature and closeness of the co-operation and mutual responsibility inseparably linking each municipality with all the others, with the rest of the system of which it is a part, and with the Commission which administers the system.

In conclusion, may I express my appreciation and the appreciation of my colleagues of the relationship which exists between the various branches of your association and The Hydro-Electric Power Commission of Ontario. I can sincerely say to you that our dealings with your various representatives and with the members of your Association have been most agreeable and have been a distinct source of pleasure and satisfaction to me and I hope as we go along our way that we will be conscious of an even closer community of interest. It is through a recognition of that community of interest and the spirit of mutual helpfulness that we shall be able to make the most of our very great opportunities to serve the best interests of the power users of this Province.

Perhaps you will also permit me to say one word about the staff. I feel that I have been a trifle reticent on this subject, probably because I have so recently been a member of the staff as distinct from the Commission. I want the Ontario Municipal Electric Association to know that it is fortunate to have the administration of its interests in such capable hands. And the Commission's staff is not only capable; it is experienced, very loyal and devoted to the Hydro service. These remarks, of course, apply equally to the staffs of the local Commissions.

# Uchi-Crow River Transmission Line

By Gordon Mitchell, Assistant Construction Engineer, H.E.P.C. of Ontario

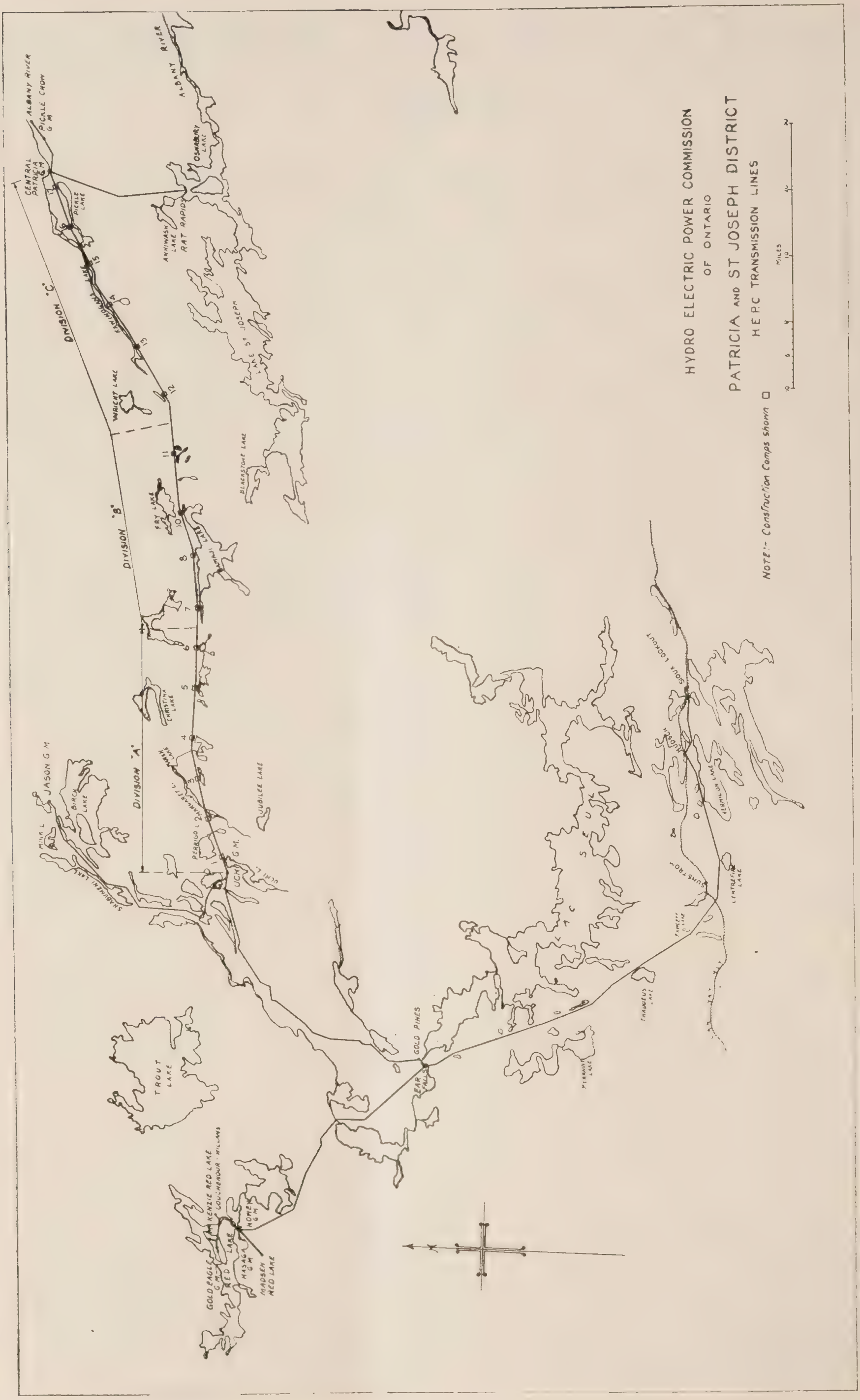
STIMULATION of the gold mining industry in Northwestern Ontario has been accentuated by the increased price of gold. This has resulted in a demand for electric power in rapidly increasing quantities and has meant the building of additions to existing generating plants, and the construction of new transmission lines.

The first generating plant built in this district was at Ear falls on the English river just at the exit of Lac Seul. This plant of 5,000 h.p. went into service in 1929 and served the Red lake district, in which is located Howey gold mine, by means of a 40 mile transmission line. The next plant built was at Rat rapids on the Albany river just at the exit of lake St. Joseph. This plant of 1,500 h.p. went into service in 1934 and served the Pickle lake area, in which is located Central Patricia and Pickle Crow mines, by means of a 25 mile transmission line. The distance between these two plants is approximately 136 miles.

Owing to the increased demands for power of Central Patricia and Pickle Crow mines the capacity of the Rat Rapids station was increased in the spring of 1936 by the addition of another unit of 1,800 h.p. Also in the fall of 1937 Ear Falls generating station capacity was increased by 5,000 h.p. This latter addition was necessary because of new mining properties going into production in the Red lake area.

Early in 1938 Uchi Gold Mines in the Woman lake area, which is northeast of Ear Falls generating station, decided to go into production and a transmission line about 48 miles long was constructed to the mine in the summer and fall. Also Central Patricia and Pickle Crow mines asked for additional power. Due to the fact that it was not practical to install another unit at Rat Rapids because of flow conditions, it was necessary to build either a new generating station 25 miles down the Albany river or a new transmission line from the Central Patricia mine westwards to connect with the existing line from Ear Falls, which terminated at the Uchi mine. The latter installation was decided on, and it is the construction of this line that will be described in the remainder of this article.

The line is known as the Uchi-Crow River transmission line. It is a 66 kv. wood pole (wishbone) line with No. 000 a.c.s.r. conductor, ¼ in. steel sky wire and a telephone circuit. Its termini are Uchi mine on the west and Central Patricia mine on the east and its length about 113 miles. Uchi mine is north of Hudson on the




Map showing location of Uchi-Crow River transmission line.

*Typical aeroplane view of country through which the line passes.*

Canadian National Railways main line to Winnipeg and is about 70 miles by airline from that point. A tractor road is open to Hudson in the winter, but it is inaccessible except by aeroplane in the summer. Central Patricia mine is north of Savant Lake on the C.N.R. main line and is about 90 miles by airline from that point. There is a tractor road to Savant Lake in the winter and in the summer a water route to Hudson.

The country traversed by this line is through virgin bush and is generally flat with few hills over 20 ft. high. Because of its flat nature there are numerous lakes and muskeg areas. The timber is mostly jack pine and spruce, which is quite small, although there are occasional patches of saw logs, but they are few and far between.

On December 16th, 1938, instructions were issued to proceed at the west or Uchi end, with clearing the line and cutting and distributing poles and cross arms. This was intended at this time merely as a relief measure to put men in the district to work.

An immediate start could be made in clearing because of the existence of camps which had been established and were still operating on the Ear Falls-Uchi transmission line. Accordingly on December 17th a start was made on clearing a road along the right-of-way to the first camp site—3 miles from Uchi mine. For purposes of construction, sites were chosen, on the topographical map of the district, for 17 camps numbered from west to east. These camps would first be used for the

clearing gangs and later for line construction. The average length of beat for each camp would thus be about 6 miles.

Camp No. 1 was established on January 1st, 1939. Clearing to the west of Camp No. 1 and a road to the next camp site were started immediately. Camp 2 was established on January 11th. Other camps on the west end were established as quickly as possible.

On December 22nd, 1938, it was decided that clearing and cutting and distributing poles and cross arms would also proceed from the east or Central Patricia end of the line. The first few foremen and men arrived on December 26th but were not able to establish camp immediately because of the time required to get camp supplies to the job. However, on January 6th Camp No. 17 was established and clearing started immediately. Camp No. 16 was established on January 9th and other camps as quickly as possible thereafter.

In addition to clearing and cutting and distributing poles and cross arms it was decided to distribute all the line material along the line for 40 miles from each end. This could be done much easier and cheaper in the winter, in fact, as noted before, summer freighting to Uchi mine is impossible. The middle 33 miles of line could be reached by water, so delivery of material to that part of the line was deferred to the summer, although this meant the opening up of an entirely new freighting route from lake St. Joseph.

After some clearing had been done on each end of the line, it was noticed that the line traversed long stretches of muskeg. This caused some misgivings because if the line was built in the summer these stretches would have to be corduroyed for roads, which would prove very costly.

It was therefore decided about January 16th that the most feasible time to build the line would be in the winter and plans were made accordingly. The programme, as set out, was to complete the 40 miles at each end of the line before spring break up leaving the 33-mile centre portion to a later date, depending on when the line had to be completed.

Line gangs and extra equipment were organized as quickly as possible. Digging of pole holes started at Camp 1 on the west end on January 31st, and at Camp 17 on the east end on February 9th.

The following comments are made on the general conduct of various phases of the work.

### Transportation

Movement of freight from railhead by road and all movement of freight and personnel by air was done by local freighting contractors. In general, all heavy supplies such as line material, gasoline and fuel oil were transported by road on sleighs and personnel and the lighter material such as food were flown to each camp site.

As noted before, there were two roads open to railhead, one at each end of the line. The freighting contractor brought the material along the line as far as the first camp, as a rule, and there dumped it. It was later picked up by Hydro tractors and sleighs and distributed along the line. In some cases, when new camps were

*Hauling poles by tractor.*

being established and a road was not cut through, a whole camp, including personnel and camp supplies, would be flown to the new site.

### PERSONNEL

A general foreman was in charge of each end of the line. Under each general foreman were two line foremen and two clearing foremen. Generally each foreman had two sub-foremen under him. Most foremen, linemen and a few tractor drivers and compressor men were sent to the job from Toronto but all common labor was obtained in the district through a representative of the Provincial Department of Labor at Sioux Lookout, (12 miles east of Hudson). In general, a good class of labor was obtained.

A maximum force of 490 men was employed, about one-half on each end of the line.

### COMMUNICATIONS

Early in January a dispatcher was established at Hudson, the railhead to which most freight was shipped. His principal duties were to order all supplies for the different camps, to direct the two transportation companies as to the allocation and destination of shipments, to arrange the supply, transportation, medical examination, pay-offs and other arrangements in connection with the labor required and to look after mail, express and freight. His was a very important and exacting job.

In the early stages of the work communication with the various camps was entirely by aeroplane but later on portable radio telephone receiving and transmitting sets were established at Hudson and in the camps at each end of the line. This greatly facilitated the ordering of supplies and personnel and was a great help in furthering the progress of the work. Foremen in camp could not only talk to the dispatcher in Hudson, but to any place on the Bell Telephone System, through

*Raising poles.*

the Provincial Government radio telephone station located at Sioux Lookout.

### Camps

All camps were "tent camps" built to accommodate about 60 men each. Where possible plank flooring was used but occasionally flattened poles had to be resorted to and these formed the only flooring throughout the camp. A maximum of five camps were going at one time at each end of the line. From the start the policy was adopted of one small gang continually moving ahead establishing new camps. This gang at times had quite strenuous going. If one can imagine establishing a tent camp in the bush with four feet of snow on the ground and the temperature 30 to 40 degrees below zero, he will realize some of the difficulties and hardships under which men have to do their work in the North Country.

In all cases camps were established on the shore of a lake, which was of sufficient size to enable aeroplanes to land.

### Clearing

There was nothing particularly difficult about the clearing except for the task of continually wallowing through deep snow. Trees were generally small, but not far from Uchi mine there were three miles of very heavy timber. In general, the line was cleared 100 feet wide but it depended entirely on the height of trees. There were occasional stretches in which there was nothing but windfall, piled sometimes as high as 8 feet. Clearing this was much more difficult than the standing trees. All brush was burnt as the clearing progressed—the logs being left on the right-of-way. In addition, a road allowance was close stumped.

### Poles

Poles were obtained wherever possible along the line. They were very scarce in certain localities. A good supply was found close to Uchi mine but no more were found on the west end until Camp 5 was reached although a few were obtained at Camp 4. Poles were hauled by tractor as far as 25 miles on this end of the line. On the east end there were a few found close to Camp 17 but it took weeks of searching to find sufficient to cover the stretch between Camp 17 and Camp 14. In fact, before finding these a considerable number had been hauled from lake St. Joseph—an 80-mile haul. The search for poles in the early stages of line construction delayed the work considerably and it was only by working tractors day and night after they were found, that the progress was kept up.

*Stringing cable.*

*Section of completed line.*

### Line Construction

There was nothing out of the ordinary in the actual building of the line. Poles were raised by gin pole and then cross arms and insulators erected. Stringing of cable was done by tractor or teams. All poles were storm guyed, and butt treated against rot.

### General

In past years, the chief difficulty in performing work in this district far removed from the railroad has been transportation of supplies and equipment. Present day transportation companies, however, are well organized with plenty of equipment and they give wonderful service. Supplies ordered from Winnipeg can be delivered the next day if flying conditions permit and there are not many days that planes cannot fly.

The chief hardship is working in extreme cold. During the whole of the month of February this year the temperature never got above 20 below zero. This cold is especially felt by the lineman on top of a pole particularly when the wind is blowing. He can protect everything except his face and there were many frozen noses and cheeks during construction. However, there is no doubt that lines in this country can be built much cheaper in the winter than in the summer because of the excessive costs in summer of making and maintaining roads along the line. It is a safe assumption to make that it would have been necessary to corduroy at least 30 percent of the total length of the line because of existence of muskeg areas and low lying swamps.

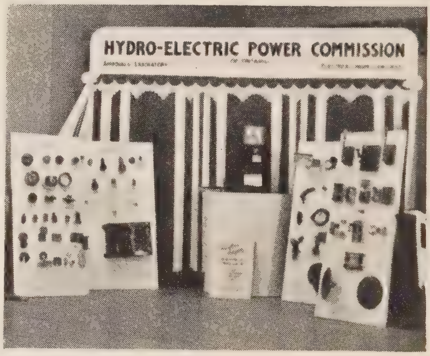
Life in camp is made as comfortable as possible. Mail comes in regularly and there is usually plenty of reading material. Radios are also supplied each camp. Usually, however, after a day spent in the cold, the man does not take long to get to bed and generally lights are all out at 9 o'clock or earlier.

# Safety Exhibit—Industrial Accident Prevention Association, Inc.

By H. J. McCaw, Electrical Inspection Department,
H.E.P.C. of Ontario

ON April 17th and 18th, 1939, the Annual Convention of the Industrial Accident Prevention Association, Inc. was held at the Royal York Hotel. It was the eighteenth consecutive convention, being attended by 3,000 registered persons and about 500 unregistered. This Convention is attended largely by plant engineers, electrical engineers, chemical engineers and superintendents, and is endorsed by most manufacturing plant managements.

A number of jobbers and manufacturers exhibited safety equipment and medical supplies. There were also exhibits by the St. John Ambulance Association, Workmen's Compensation Board and both the Departments of Labour and Highways of the Province of Ontario. The Hydro-Electric Power Commission of Ontario sponsored an exhibit, being in charge of the Electrical Inspection Department in conjunction with the Approvals Laboratory. Exhibited were a number of electrical fixtures which were in use some forty to fifty years ago, some of which have only recently been removed from service. Some of the fixtures consisted of wooden rosettes, fused and unfused; wooden fuse cutouts,




forerunners of the present cutouts; and some early porcelain cutouts. Switches of the same age were shown —some of these still being in good operating condition—and also a number of early lamp sockets of the Thompson-Houston and Edison-base types. There were also some switches and equipment of commercial type which were about the first installed in Canada, being in use until a few years ago.

A chemical meter, used in the measurement of direct current at the turn of the century, was loaned through the kindness of the Toronto Hydro-Electric System, and caused a great deal of interest.

A number of lamp bulbs from the early Thompson-Houston type to the last word in illumination were exhibited, these being part of a collection

belonging to the Photometric Laboratory of the Commission.

The Approvals Laboratory supplied a number of devices which have been rejected as unsafe for connection to the source of electrical energy. These were a few devices such as unsafe cigar lighters, water heaters, toasters made of light-weight material, fittings, etc.

A few devices which have caused fatal accidents were shown, such as cord sets, air heater, bed lamps, etc.

Great interest was shown in the booth, especially the second evening when there was a line-up for almost two hours to see the exhibit. It was surprising to hear comments from interested people, to realize how much they know of Hydro Inspection and Approval, and also as to their knowledge of equipment that has been condemned.

As evidence of how successful the Convention was, the two luncheons and first evening banquet were sold out well before starting time, there being in the neighbourhood of 900 in attendance at each. At the mass meeting held the second evening, the attendance was about 1800 persons.

This was the Commission's first venture in educational work of this type, and the response to the efforts was indeed gratifying.

The picture of the exhibit was a night snapshot made by G. M. Neff, manager of the Safety Exhibit.

# Wise Precautions in the Use of Electrical Equipment

AN average of two or three fatalities occur in Ontario each year as a result of defective equipment operating at a potential of only 120 volts and it is felt that some further word of caution should reach the consumers who in most cases are not aware of the possible hazard which prevails. There seems to be a general impression that the ordinary domestic circuit of 120 volts is perfectly safe and whereas this is true under normal circumstances, a fatal shock is quite possible with a combination of a defective appliance and a low resistance path to ground.

The use in a bathroom of portable equipment such as heaters, sun lamps and electric razors, constitutes a real hazard and it is the duty of every hydro official and employee to constantly warn the public against the danger which exists. Legislation already provides for approval of the design of equipment and prohibits the installation of wall or baseboard outlets in a bathroom, but the improper use of such equipment is necessarily a matter for the consumer himself.

There are thousands of portable heaters in use throughout the province. Many of these are undoubtedly defective although the condition may be unknown to the consumer. These heaters might be used constantly around a living room or bedroom and as long as they were handled without establishing contact with ground through a medium such as a water pipe, radiator, hot air register, etc., no shock would be received although the hazard is actually present. With the heater used in a bathroom the danger is increased many fold, and if defective equipment is handled by a person standing or sitting in a bathtub, a fatality is almost inevitable. When it is realized that a voltage as low as 20 to 30 volts may pass sufficient current to prove fatal, the hidden danger which exists will be better appreciated. *As a matter of fact, equipment requiring an extension cord should never be used in a bathroom.*

Another serious hazard prevails in a basement where a defective washing machine or pump motor may produce a dangerous potential to ground. Similar conditions may be encountered with brass sockets or extension cords on irons or toasters, and these should never be handled when standing on a damp floor or when any part of the body is touching a water pipe.

Most people have at some time experienced an electric shock from household equipment and have only given it a passing thought. There seems to be a mistaken impression that these shocks are not harmful, and in fact, may even be beneficial. This theory cannot be too strongly contradicted, and if a shock is received when working around the house it should be reported immediately to the proper authorities. The point to keep in mind is the hidden danger which is lurking in the equipment and the fact that if conditions approaching those which prevail in a bathroom, had been present in these other instances, any one of these so called trivial shocks might have proved fatal.

Cases have been reported of men using an electric razor while sitting in a bath. There is a further report of a lad who carefully lathered his face and when the electric razor failed to operate satisfactorily, plunged it into a basin of water. Then there is the case of the man who attempted to do some wiring and worked from the source of supply outwards. His young child was electrocuted by picking up a live circuit wire and putting it in his mouth.

These incidents are almost incredible, but simply serve to emphasize the necessity of education on the part of the public so that the many appliances which are of untold benefit and enjoyment when properly handled, may not become the cause of a regrettable fatality.

* * * *

Note: As the foregoing should be brought to the attention of the public, we suggest that the article be reprinted in the local newspapers.

—Editor.

# Safety in Electrically Equipped Homes

By J. E. Ritchie, B.A.Sc., Fire Prevention Engineer,
Ontario Fire Marshal's Department

THE safe use of electrical appliances depends primarily on the standard of wiring through which the electrical current is distributed in the building. Unless the wiring has been installed by a competent electrician and inspected by a proper authority to ensure that it is in accordance with the prescribed regulations, it may in itself constitute a hazard in addition to aggravating further hazards introduced by the improper placing or installation of current-consuming appliances.

It is a sign of trouble when sockets hiss or lamps flutter, when plugs are loose in wall outlets, when the wall switches fail to function, when insulation on the wires is injured, when it is possible to get a shock from an appliance, or when an appliance fails to operate or causes a blown fuse. It is essential that the trouble be removed before any such warning or failure grows into a real hazard.

Electricity, properly harnessed and properly handled, is not dangerous in the customary acceptance of that term. Installations that are properly made, and properly maintained and utilized, offer very little hazard of fire, except when some abnormal circumstance develops. Almost all fires from electricity are the result of improper installation, improper maintenance, substandard extensions, or the overloading of individual circuits.

### NEEDS EXPERT SUPERVISION

The characteristics of electrical energy are more or less obscure, and the ordinary householder is not sufficiently familiar with the technical aspects to know whether it is being safely applied or handled. For this reason expert supervision is necessary when electrical energy is being handled.

Everyone knows that when an electric current passes through the very fine wires in an electric light bulb it produces a high temperature in the wires so that they become "white hot." It may never have occurred to the average consumer, however, that if a sufficiently large current is allowed to pass through larger wires that constitute the house wiring, these, too, will reach a temperature so high that a fire may result. To prevent this, the Electrical Inspector examines wiring when an installation is completed, just to make sure that the wires are large enough to carry safely the amount of current required, and that fuses and other pieces of equipment are properly installed.

It is well known that electricity applied under certain conditions may be fatal, particularly where a high voltage is used. Even at the voltage ordinarily used in homes, electricity can be very dangerous if allowed to pass freely through the body. The Electrical Inspector safeguards the public

in this respect, by ensuring that appliances and wires are properly insulated.

### Code of Rules

To prevent the public from electric shock and electrical fires, a code of rules, formulated by The Hydro-Electric Power Commission, has been made a part of the law of the Province of Ontario. In recent years the code has been standardized to apply to all the provinces, and the provinces are taking steps to adopt it. Under the code, as it is now enforced in Ontario and as it will be enforced in other provinces, facilities are provided for testing electrical appliances and materials so that only those which are entirely safe to use will be placed on the market.

Proper use of electrical wires and equipment is just as important as proper materials and proper installation. Allowing electrical equipment to fall into disrepair is responsible for most of the fires charged against electric service. Too often, electric fixtures are subjected to usage for which they were never intended. It is not uncommon to find articles, sometimes of considerable weight, hanging on electrical brackets and subjecting them to an abnormal strain with the danger of causing injury to them or to the wiring that is connected to them. Fires and shocks resulting from such improper practices should not really be charged against electricity but against utter carelessness on the part of the user.

Nearly everyone at some time has received slight shocks from electrical equipment without any ill effects. Sometimes, however, those shocks may be dangerous, especially if the hands are wet. Electric fixtures in bathrooms, the handles of wall switches, and the cover plates for all electrical outlets should be made of porcelain, plastic or some other insulating material. An insulating link in the chain of a pull-chain socket increases safety if there is any probability of the socket being operated with wet hands.

Safety precautions built into the permanent wiring of a house are of no avail if the last links in the wiring chain — the attachment cords — are either not suitable or not kept in good repair. Fortunately it is relatively easy to observe when cords are wearing out, because, unlike other parts of the wiring system, they are in plain view. As the result of the severe abuse that electrical cords are given in the average home they will almost undoubtedly wear out sooner or later, but some cords are so much more substantially made than others that it pays to take care in choosing them.

### Extension Cords

In addition to flexible cords for the attachment of electrical appliances many people use portable extension cords for electric lights, electric drills or other movable pieces. Such extensions are not recommended for permanent attachments, but they are certainly handy and are very widely used. If they are used on damp earth or in the vicinity of grounded metals, good insulation is of extra importance. In such locations sockets of insulating material should be used, and lamps should be protected by guards.

Fuses play an important part in

guarding the safety of the electrically equipped home, and their use should not be scorned. Some people, when a fuse blows, replace it with a copper coin, thus allowing the current to flow unchecked. Such actions defeat the very purpose of the fuse, and create added danger of fire. Fuses of the right capacity should always be used in replacing old blown ones. If too much current is allowed to flow through the wiring, insulation may be injured by excess heat, or a fire may even start in the affected wiring. Ordinarily the fuses in house wiring circuits should not have a current-carrying capacity of more than 15 amperes, unless some fully qualified electrician or inspector has advised that the wiring is suitable for a heavier fuse.

It would hardly seem necessary to warn against leaving electric irons connected to the circuit, but, as a matter of fact, overheated flatirons have probably been responsible for more fires than any other electrical appliances. Most of those fires occur when the operator has forgotten that the iron is connected; in many cases when the operator has left home. It might be a good thing if everybody remembered that the one sure way of turning off an electric iron is to disconnect the cord. Otherwise, if the iron is connected to an ordinary wall socket it is hard to tell when the current has been shut off.

There is another reason why lamp sockets should not be used to supply current to electric irons. The switching mechanism in such sockets is designed to control incandescent lamps which, for home use, seldom exceed 200 watts. As electric irons require from 500 to 1,000 watts, they overload the switch mechanism with possible danger to the sockets.

### Electric Washers

Electric washing machines present additional difficulties because they must necessarily be used in the presence of water and grounded piping systems, and sometimes on damp floors. For those reasons special precautions should be employed when the machines are in use. Motors of washing machines are usually well insulated, but if the motor is allowed to get wet its insulation may be impaired. Cords used on washers are especially likely to become defective, and only rubber-sheathed cords of good quality should be used in this connection. It is very important to replace them when they become worn. If an electrician is employed to connect a special wire between the frame of the washer and a water pipe, you will have assurance that any failure of insulation, which might otherwise create a dangerous situation, will immediately be indicated by the blowing of a fuse.

The electric heating pad is a very helpful appliance, especially in case of sickness, and may be used with safety if a few fundamental principles are observed. Sharp folds in the pad should be avoided. It should not be pulled from place to place by the cord, or the connection may be broken inside the element. It should not be hung up by a hook, and pins should never be pushed through it, for fear they might make a contact with the heating element. If they did, they would become live and might constitute a shock hazard or even result in

the destruction of the element. It is also very important that heating pads be kept dry.

Get Experienced Men

Since electricity and its dangers are not understood by the public, and since a little knowledge of those things may prove more dangerous than no knowledge at all, the householder should always employ experienced men to make repairs and additions to house wiring. All appliances should be kept in good order and due respect should be paid to all wires and fixtures as long as they are in service. If installations are properly made, and if maintenance is based on good practice and in accordance with the standard regulations, there is little if any, danger of either fire or shock from the use of approved electrical appliances.

# Hamilton "Hydro-Dealer Co-operative Sales Plan"

IN March of this year, the Hamilton Hydro-Electric System, after a study of local conditions in the electrical trade, introduced a Co-operative Sales Plan to Hamilton dealers and manufacturers. The Plan at present applies to range sales only.

While still in a tentative form, the Co-operative Plan was described at organized meetings of contractors and dealers and criticisms pro and con were invited with the result that the final Plan was acceptable to and appreciated by both contractors and dealers who have since co-operated with the Hydro splendidly.

The Plan was then published in the form of a booklet entitled "The Hydro-Dealer Co-operative Sales Plan" and is familiarly known by the Hydro and by the dealers as "The Red Book". From this booklet, co-operators in the Plan may find full particulars concerning wiring and trade-in allowances and the Hydro Thrift Plan.

Under the Hydro-Dealer Co-operative sales Plan, the Hamilton Hydro-Electric System does not limit its contributions to wiring costs of new ranges alone. Wiring allowances are also made on the sale and installation of used ranges provided that in each case the range is approved by the Hamilton Hydro-Electric System as being in reasonably efficient condition.

Electric range owners moving to homes not wired for ranges may thus obtain wiring allowances. This feature is very popular with electrical contractors who, in order to increase their business, are always on the lookout for such cases, thus "saving the load" for the Hydro.

In connection with the Demonstration Week organized by the Hydro-Electric Power Commission, the Hamilton Hydro-Electric System organized further promotional meetings with both dealers and manufacturers. Dealers subscribed on a fifty-fifty basis towards the cost of the Slogan Competition and manufacturers co-operated


*Hamilton Hydro window display during Electric Demonstration Week.*

with their dealers and the Hydro in extensive advertising, planned well in advance, at a meeting with the manufacturers. At this meeting, continuity rather than duplication of advertising effort was arranged.

The result has been an already substantial and accelerating increase in range connections.

One interesting result of the organized meetings has been the founding of an electrical appliance club, holding fortnightly luncheon meetings of a social and educational nature, membership in which is restricted to persons engaged in the electrical appliance trades.

The Club now provides a medium through which manufacturers or the Hydro can present further promotional schemes and through which the dealers while meeting one another socially can learn "what's new" from selected speakers.

# Sarnia Electric Show

ONE of the most successful demonstrations and electrical shows ever held in Sarnia was that on May 2nd to May 6th. Over 3500 adults representing Sarnia and district visited the show and were keenly interested in the special displays.

This was the first All Electric Show ever to be held in Sarnia and the results were amazing. During the show, each dealer secured a number of sales in addition to a large follow-up list.

It also represents an outstanding achievement in organization as it was the first time the electrical dealers of Sarnia ever co-operated together in a special undertaking of this kind and the results obtained warrant carrying on in a similar co-operative basis. In-


*Sarnia Hydro exhibit at the show.*

cidently, the dealers were so pleased, it was suggested that a get together dinner be held to celebrate the occasion.

The public response was excellent. They showed a great deal of interest in the special lighting and various products displayed. Dealers also report since the show a considerable number of sales resulting directly from the display.

The Stirrett Winter Garden was selected for this display as it was the only place in Sarnia with a suitable number of outlets and sufficient wiring for a show of this kind. Twenty-six special lighting units were installed which helped brighten up the hall and displays. Each dealer was alloted space approximately 18 feet long by 9 feet deep. A minimum cost was set up for each dealer, \$5.00 for space, \$15.00 for advertising and prizes at a list value of \$25.00. Anything additional they cared to spend in advertising or display was left to themselves. The show was officially opened by Mayor Norman Perry, A. N. Galloway, the Chairman of the Hydro Commission and J. E. B. Phelps, the Hydro manager. A drawing for six prizes at ten o'clock, also, some form of entertainment was given each evening.

On the final night the drawing for the Grand Prize, an electric range, was held at 10:30 p.m. Over 500 people were in attendance. A rotating drum was used and a young lady was blindfolded and the thirteenth ticket was the lucky winner. Incidently this happened to be a customer using gas and the rules stated it must be put in use in Sarnia, so we received a new load.

A code was set up for the show governing prices, trade-in allowances, carrying charges, etc. This resulted in good feeling all during the show.

# Water-Power Resources Of Canada

THE Dominion Water and Power Bureau of the Department of Mines and Resources, Ottawa, presents a review of the outstanding features of the developed and undeveloped waterpower resources of Canada.

### TOTAL AVAILABLE AND DEVELOPED WATER-POWER

The results of studies indicate available water-power totalling 20,347,400 h.p. under conditions of ordinary minimum flow and 33,617,000 h.p. ordinarily available for six months of the year. The total turbine installation, as at January 1, 1939, is 8,190,772 h.p. Of these total amounts the available water-power under conditions of ordinary minimum flow in Ontario was 5,330,000 h.p. and 6,940,000 h.p. ordinarily available for six months of the year. The total turbine installation in Ontario was 2,582,959 h.p.

The analysis shows the average machine installation to be 30 per cent. greater than the ordinary six months flow power. Thus, the figures quoted above indicate that the *present recorded water-power resources* of the Dominion will permit of a turbine installation of about 43,700,000 h.p.

### UTILIZATION OF DEVELOPED WATER-POWER

Canada's total hydraulic installation of 8,190,772 h.p. is shown under the three main headings of central electric stations, pulp and paper mills, and other industries.

The installation in central electric stations, the largest and most rapidly growing class, represents the power developed for the sale of electricity to meet the general industrial, commercial, municipal, domestic, and agricultural demands of the public. In all 7,202,259 h.p. or 87.9 per cent. of the total hydraulic installation of Canada is so developed of which 2,248,883 h.p. are in Ontario. Pulp and paper mills have an aggregate hydraulic installation of 646,901 h.p. or 7.9 per cent. of the total, 228,377 h.p. being in Ontario, and the installation for other purposes totals 341,612 h.p. or 4.2 per cent. of the total, Ontario having 105,699 h.p.

The average installation per 1,000 population is 731 h.p., a total which places Canada in an outstanding position amongst the water-power using countries of the world.

These figures show Ontario to have a total of 2,582,959 h.p. installed with an average of 692 h.p. per 1,000 population.

### WATER-POWER IN THE CENTRAL ELECTRIC STATION INDUSTRY

Almost 88 per cent. of Canada's total hydraulic development is installed in central electric stations and this represents more than 95 per cent. of the main plant generating equipment of the industry. This equipment generates more than 98 per cent. of the total electricity produced for sale in Canada and for export. In the ten-year period

between the end of 1928 and the end of 1938 the central station hydraulic installation increased by 2,756,566 h.p. as compared with an increase of only 84,974 h.p. for all other purposes, i.e., less than 3 per cent. of the total hydraulic installation of the past ten years has been developed by other than central station organizations.

As the output of the hydro-electric stations represents 98 per cent. of the total, the inclusion of the output of the fuel power stations has little effect upon the averages quoted. According to the latest figures available, those for the calendar year 1937, Canadian central stations generated a total of 27,687,645,000 kw-hr. of which 1,843,227,000 kw-hr. or 6.7 per cent. was exported to the United States. Including a small import from the United States, 1,317,000 kw-hr., there was a total of 25,845,737,000 kw.-hr. for distribution in Canada. Of this, 7.8 per cent. was sold for farm and domestic use, 3.7 per cent. for commercial lighting, 2 per cent. for small power use (less than 50 kw. per customer), 76.7 per cent. for large power purposes (more than 50 kw. per customer) and ¾ of one per cent. for street lighting.

The pulp and paper industry is the chief customer for large power, purchasing during 1937, more than 10¼ billion kw-hr. or 50 per cent. of all industrial power sold. Of the power so purchased more than 5⅓ billion kw-hr. were used for raising steam in electric boilers.

The electro-chemical and electrometallurgical industries are also very large purchasers of industrial power, purchasing during 1937, a total of 3,960,344,000 kw-hr. or 19½ per cent. of all industrial power sold by central stations.

### Water-Power in the Pulp and Paper Industry

The pulp and paper industry ranks high amongst Canada's manufacturing industries, leading all others in total number of persons employed and in salaries and wages paid. It contributed more than 57 per cent. to the Dominion's favourable trade balance of 1937. Its development has been extremely rapid, the output of its chief product, newsprint, increasing in 1937 to an all-time record of more than ten times the output of 1913, the first year for which complete figures are available and amounting to 41 per cent. of world production for that year. While there was a considerable reduction in newsprint output during 1938, this was somewhat offset by a substantial increase in the contract price for the year.

The outstanding manufacturing feature of this industry is the enormous consumption of power in the process of converting the timber into paper and it is the fortunate occurrence of ample and readily developable water-power in conjunction with abundant supplies of the various pulpwood species which has made the present development of the industry possible. When it is stated that a mechanical power installation of approximately 100 h.p. is required per ton of daily output of newsprint and that in addition about an equivalent amount of hydro-electricity is at times utilized for the production of process steam the contribution of low-cost hydro-power to the success of the in-

dustry becomes evident. While the power consumption per unit of output of the higher grade papers manufactured by the three chemical processes in use in Canada is much less than for newsprint, it is still a factor in economical production.

Canada's pulp and paper mills maintain a hydraulic turbine installation of 646,901 h.p., have an electric motor installation for operation by purchased hydro-electricity of 1,200,000 h.p., and purchase 50 per cent. of all industrial power sold by central electric stations. During 1937 fifty-two per cent. of this purchased power was used for the production of steam in electric boilers.

### Water-Power in the Mineral Industry

In every branch of the mining industry, from the preliminary drilling to the final refinement of the product, large amounts of power are essential; as even the comparatively straightforward operations involved in the recovery of coal require the power equivalent of as much as 10 per cent. of the product.

In many cases large scale operations which alone make the difference between profit and loss are only made possible by abundant supplies of low-cost hydraulic power. Many mines on account of their geographical location would find the cost of rail haul on fuel or untreated ore prohibitive but, with hydraulic power, profitable operation has been possible and much low grade material has been given commercial value.

The principal mining areas of Canada at the present time are the placer gold and silver-lead deposits of the Yukon Territory, the coal and metallic ore fields of British Columbia, the coal and crude oil fields of Alberta, the gold deposits near Great Slave Lake and the radium-uranium deposits near Great Bear Lake in the Northwest Territories, the gold deposits near Lake Athabaska in Saskatchewan, the gold and copper zinc-sulphide deposits in Northern Saskatchewan and Manitoba, the gold deposits in Eastern Manitoba, the gold, silver and copper-nickel (with its accompanying platinum group metals) of Northern Ontario, the copper-gold area of Northwestern Quebec, the asbestos fields of the Eastern Townships of Quebec and the coal fields of the Maritime Provinces. In practically all of these fields with the exception of the last mentioned hydro-electric power is used for all large scale operations and it is estimated that more than 800,000 h.p. is generated by the mining companies or purchased by them from central electric stations.

### Water-Power in Other Industries

In addition to maintaining the hydraulic installation of 341,612 h.p., these diversified industries provide a broad market for hydro-electricity generated by the central electric stations by purchasing power to operate an electric motor installation of more than one and three-quarter million horse-power.

### Growth of Water-Power Development

The growth of water-power development in Canada from 1900 to the present time shows that total water-power installation has grown from 143,156 h.p. at January 1, 1900 to 8,190,772 h.p. at January 1, 1939.

### Capital Invested in Water-Power

The capital investment represented by Canada's present hydraulic installation of 8,190,772 h.p. is conservatively estimated at $1,650,000,000.

### Coal Equivalent of Developed Water-Power

Comparing the water-power development in the Dominion with a corresponding development of fuel power under comparable conditions indicates that each installed hydraulic horse-power if operated continuously throughout the year would effect a saving of about 4.64 tons of coal or that the present installation of 8,190,772 h.p. is capable of effecting a saving of thirty-eight million tons of coal.

During 1938, Canadian consumption of electricity produced in central electric stations was 24,167,884,000 kw-hr., about 99 per cent. of which was hydro-electricity including 5,787,537,000 kw-hr. sold for electric boiler use. Adding to these figures a conservative estimate of the power output of non-central station hydro plants indicates that the water-power used for general power purposes effected a saving of 15,522,500 tons of coal while in electric boilers the saving amounted to 972,988 tons. That is during 1938, water-power effected an actual saving of some 16,500,000 tons of coal.

The foregoing brief review of the water-power resources of Canada will serve to indicate their importance to the present and future industrial and domestic life of the Dominion. Large undeveloped powers still remain within easy transmission distance of the principal centres of population, the development of which will ensure adequate power for a considerable time to come.

# J. G. Hare, East York Township

Jonathan George Hare, manager of The Hydro-Electric Commission of East York, died on Tuesday, April 25th, 1939. On the night of Sunday, April 9th, he had suffered a stroke from which he did not recover.

Mr. Hare was born on May 13th, 1880, in Cork, Ireland. He received his education in Cork and served an apprenticeship in civil engineering in the Civic Office of Cork. In 1906, he was appointed assistant in the City Engineer's office where he served until 1912, when he came to Canada. On arriving in Canada, he was employed as a draughtsman with the Canadian Bank of Commerce and in laying out the electric lighting of the branch banks. In 1915, Mr. Hare enlisted in the Canadian Army and served in the camp at Kapuskasing until 1916 when he was discharged owing to injuries he had received in his right hand. He then went into business for himself as an electrical contractor and draughtsman and continued in it until 1923 when he entered East York Township office as draughtsman. He was appointed assistant superintendent of the East York Hydro-Electric Commission in 1925, and in the following year was made manager and engineer, which position he held until his death.

Mr. Hare was a member of the Association of Professional Engineers of

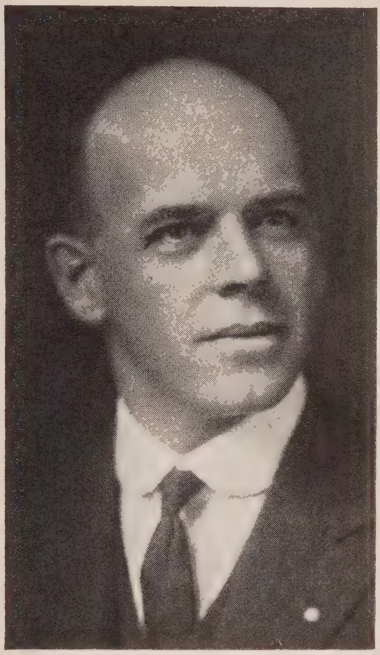
the Province of Ontario and of the Electric Club of Toronto. He was a past president of the Canadian Legion, Post 10.

In the performance of his duties he was very conscientious, and although of a retiring nature made many friends.

## W. G. Henderson, Cobourg

Stricken suddenly, while apparently on the road to recovery from an illness of considerable duration, William George Henderson, manager of the Cobourg Public Utilities Commission, passed away on Monday, May 1st, 1939.

Mr. Henderson was born at Keene, Ontario, fifty-one years ago and received his education in Peterborough, Ontario, and Grand Rapids, Michigan. In 1909, he entered the utilities field with the Peterborough Electric Light and Power Company and continued with The Electric Power Company when it took over the distribution in Peterborough. Later, in 1913, when the city of Peterborough contracted with The Hydro-Electric Power Commission for power and bought the local distribution system, he continued in the employ of the Peterborough Utilities Commission. Here he remained as accountant until 1925. He took an active interest in the development of mechanical billing of consumers' accounts and was instrumental in having the Peterborough office one of the first to have a system installed.



*W. G. Henderson*

From the Peterborough Utilities, he went to the Remington Rand Company, and later, to the Burroughs Adding Machine of Canada, Limited, for both of which firms he contacted utilities in Eastern Ontario and Quebec. In 1933, he accepted the position of accountant in the office of the Cobourg Public Utilities Commission where he became manager in 1936.

Mr. Henderson was highly esteemed in Hydro accounting circles and among the Hydro utilities. In 1938, he was a district director of the Association of Municipal Electrical Utilities, and chairman of the committee on Accounting and Office Administration.

# O. M. E. A. and A. M. E. U. CONVENTION

## At Chateau Laurier, Ottawa
## On July 4th and 5th, 1939

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### TUESDAY, JULY 4th, AT 9.30 A.M.

O.M.E.A. Business Meeting.

A.M.E.U. Convention Session.

Paper—"Modern Developments in Distribution Transformers," by W. L. Millar, Engineer, Canadian Westinghouse Company, Limited, Hamilton.

Guided Discussion.

### AT 7.00 P.M.

Convention Dinner, Musical Entertainment, Address by Dr. Thomas H. Hogg, Chairman, The Hydro-Electric Power Commission of Ontario.

### AT 10.00 P.M.

Convention Dance.

### WEDNESDAY, JULY 5th, AT 8.30 A.M.

A.M.E.U. Accounting Session

Breakfast meeting arranged by the Committee on Accounting and Office Administration.

### AT 9.30 A.M.

O.M.E.A. and A.M.E.U. Joint Convention Session.

Paper—"Public Utilities and the Ontario Workmen's Compensation Act," by Norman Dean, Statistician, Workmen's Compensation Board of Ontario.

Address—"New Business," by M. J. McHenry, Director of Sales Promotion, The Hydro-Electric Power Commission of Ontario, assisted by his staff.

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### HOTEL RATES

Single room with bath, $4.00 per day.
Double room with bath, double bed, $6.00 per day.
Double room with bath, twin beds, $7.00 per day.

# THE BULLETIN

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# Annual Report, 1938

## Extracts From the Chairman's Letter of Transmittal of the Thirty-First Annual Report of the Hydro-Electric Power Commission of Ontario for the Fiscal Year Ending October 31, 1938

THE record of the Commission's work presented in this Annual Report relates to three principal fields—the co-operative municipal field, the field of rural supply, and the Northern Ontario field. The first two cover the Commission's activities on behalf of the co-operative systems, and the last relates to its trustee-ship of the Northern Ontario Properties on behalf of the Province. Throughout the various sections of the Report dealing broadly with physical operation of the plants, constructional activities and financial statements, these fields of activity are clearly differentiated.

The Report also presents for the calendar year 1938 financial statements and statistical data relating to the municipal electric utilities operating in conjunction with the several co-operative systems for the supply of electrical service throughout the Province.

### Operating Conditions

Operation of the plants on the Niagara river was severely affected by an unprecedented ice jam in the lower river in January, which backed up the water to such heights that on January 26, the Ontario Power plant was flooded with water and ice and completely put out of commission. The output of the Queenston plant at times was curtailed due to high tail-water. This condition was relieved about the middle of March, when a large portion of the ice jam in the river below the plant moved out.

Apart from the disaster to the Ontario Power plant, operating conditions throughout the several systems of the Commission was satisfactory. Precipitation was above normal and stream flow was adequate to meet all demands.

In the Niagara system, notwithstanding the loss of the output of the Ontario Power plant, the Commission

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**Vol. XXVI** **No. 6**
**June, 1939**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission: to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interested are invited for publication.*

was able to maintain full delivery of primary power to all customers.

To supplement the output of the power plants on the Georgian Bay system, power was transferred from the Niagara system, and purchased from the Water, Light & Power Commission of Orillia. With the completion of the Ragged Rapids plant, one unit of which was placed in service on October 18, 1938, it is anticipated that the necessary assistance from outside sources can be supplied from the Niagara system, through the Hanover frequency-changer set, for some time to come.

The output available from the generating plants of the Eastern Ontario system, together with the additional 18,000 horsepower which under the revised agreement with the Gatineau Power Company became available on October 1, 1938, enabled all primary power demands to be met. Certain quantities of secondary power were also available. These were supplemented by transfer of power from the Niagara system, sufficient in quantity to meet fully the secondary power demands of the Eastern Ontario system.

In the Thunder Bay system no difficulties were experienced in meeting the primary demands for power, notwithstanding the fact that in September the primary peak load, due to exceptional demands by the grain trade, reached the highest total on record. Precipitation on the watershed of the Nipigon river was about 16 per cent above average, and the operation of the Cameron Falls and Alexander developments was satisfactory.

The market for secondary power in the Thunder Bay system, although less than the previous year, was great enough at times to use more power than could be supplied by the Nipigon river developments. Consequently the arrangements previously in force with the Abitibi Power and Paper Company were continued throughout the year. These arrangements permitted the pulp and paper mills under the control of the above Company to obtain over the Commission's lines and stations a supply of secondary power from the Kaministiquia Power Company.

In Northern Ontario water storage and stream flow conditions associated with the operation of the power

plants serving the various districts were satisfactory. The stream flow on the Abitibi river was adequate to meet all primary and secondary demands of the Abitibi district. The addition in March, 1938, of a fourth transformer bank at the Abitibi canyon generating station permits concurrent operation of four of the five 60,000 horsepower generators. The storage dam to control Frederick House and Night Hawk lakes was completed in time to impound the Spring run-off in 1938. Acquisition of the Crystal Falls generating station in 1937 relieved the power situation in the Sudbury and Nipissing districts, and greatly improved operating conditions.

### REHABILITATION OF THE ONTARIO POWER PLANT

When the flood that inundated the Ontario Power plant receded twenty-four hours later, it left behind it about 7,000 tons of ice and a heavy deposit of oil over everything that had been submerged.

Rehabilitation of the Ontario Power plant was an undertaking of major proportions, which taxed the ingenuity of the Commission's engineers. In 1909 all attempts to dry the large generators submerged in a similar flood had been unsuccessful, and the consensus of opinion among those who had had recent experience of flood-damaged plants elsewhere was that attempts to dry out the large generators would not prove successful. However, the engineers responsible devised new methods and ingenious apparatus, and their efforts were rewarded by complete success.

### LOAD CONDITIONS

The general upward trend of the aggregate primary loads of the co-operative systems and Northern Ontario Properties which had been experienced since the major depression of 1932, flattened out in the latter part of 1937, and then showed a slight recession until near the end of the fiscal year which ended in October last. A comparison of the October, 1938, primary peak with that of October, 1937, for all systems and the Northern Ontario Properties showed an increase of 1.7 per cent. Following the end of the fiscal year an upward trend became apparent.

In the Niagara system, about four-fifths of the primary load represents load supplied to municipal utilities; the balance goes to large industrial consumers of the system, supplied direct by the Commission, chiefly electro-chemical and electro-metallurgical industries along the Niagara river. These large industries are very sensitive to industrial conditions in the United States and their power requirements in 1938 were greatly reduced. The municipal load therefore provides the best barometer of general conditions throughout southern Ontario. The winter peak of the high-tension municipal load which occurred in December was 6.2 per cent. higher than the winter peak of 1937-1938.

The peak load of the Georgian Bay system occurs in the summer months and in 1938 this primary peak load was the highest ever carried. It occurred in the month of July, and was 8.4 per cent higher than the peak load of the previous summer. The primary peak of the Eastern Ontario sys-

DISTRIBUTION OF PRIMARY POWER TO SYSTEMS

20-MINUTE PEAK HORSEPOWER—SYSTEM COINCIDENT PRIMARY PEAKS

| System | 1937 | 1938 |
|---|---|---|
| | October | |
| Niagara system—25-cycle | 1,036,997 | 1,040,214 |
| Dominion Power & Transmission division—66⅔-cycle | 57,507 | 46,515 |
| Georgian Bay system | 29,310 | 30,891 |
| Eastern Ontario system | 125,395 | 128,586 |
| Thunder Bay system | 88,800 | 93,606 |
| Manitoulin rural power district | 137 | 205 |
| Northern Ontario Properties: | | |
| Nipissing district | 4,812 | 4,857 |
| Sudbury district | 14,611 | 17,895 |
| Abitibi district | 93.834 | 113,160 |
| Patricia district | 5,013 | 5,697 |
| St. Joseph district | 2,708 | 2,989 |
| Total | 1,459,124 | 1,484,615 |
| | December | |
| Niagara system—25-cycle | 1,070,778 | 1,112,466 |
| Dominion Power & Transmission division—66⅔-cycle | 56,032 | 48,123 |
| Georgian Bay system | 31,314 | 34,011 |
| Eastern Ontario system | 124,718 | 132,001 |
| Thunder Bay system | 85,235 | 83,773 |
| Manitoulin rural power district | 141 | 257 |
| Northern Ontario Properties: | | |
| Nipissing district | 4,705 | 5,255 |
| Sudbury district | 16,153 | 17,954 |
| Abitibi district | 95,576 | 124,203 |
| Patricia district | 5,201 | 6,167 |
| St. Joseph district | 2,761 | 3,029 |
| Total | 1,492,614 | 1,567,239 |

tem which occurs in the winter was nearly 5.0 per cent higher than the winter peak of 1937-1938. In the Thunder Bay system, due to the movement of the grain trade, the peak load in 1938 occurred in the month of September, and was the highest primary load ever carried by the Thunder Bay system. It exceeded the primary peak load of 1937 by 7.9 per cent.

One of the more encouraging features of the past year's operations was the growth in load in the districts served by the Northern Ontario Properties. In these districts, which serve mining developments and the communities dependent upon them, the primary peak load in December, 1938, was the highest on record. It was 26 per cent higher than the primary peak of December, 1937.

Another encouraging feature of last year's operations was the con-

## DISTRIBUTION OF POWER TO SYSTEMS—TOTAL PRIMARY AND SECONDARY

### 20-MINUTE PEAK HORSEPOWER—SYSTEM COINCIDENT PEAKS

| System | 1937 | 1938 |
|---|---|---|
| | October | |
| Niagara system—25-cycle | 1,126,675 | 1,259,115 |
| Dominion Power & Transmission division—66⅔-cycle | 57,507 | 46,515 |
| Georgian Bay system | 29,310 | 30,891 |
| Eastern Ontario system | 129,584 | 159,249 |
| Thunder Bay system | 134,678 | 131,394 |
| Manitoulin rural power district | 137 | 205 |
| Northern Ontario Properties: | | |
| Nipissing district | 4,812 | 4,857 |
| Sudbury district | 14,611 | 17,895 |
| Abitibi district | 143,432 | 172,409 |
| Patricia district | 5,013 | 5,697 |
| St. Joseph district | 2,708 | 2,989 |
| Total | 1,648,467 | 1,831,216 |
| | December | |
| Niagara system—25-cycle | 1,235,523 | 1,359,786 |
| Dominion Power & Transmission division—66⅔-cycle | 56,032 | 48,123 |
| Georgian Bay system | 31,314 | 34,011 |
| Eastern Ontario system | 149,853 | 161,103 |
| Thunder Bay system | 132,038 | 132,399 |
| Manitoulin rural power district | 141 | 257 |
| Northern Ontario Properties: | | |
| Nipissing district | 4,705 | 5,255 |
| Sudbury district | 16,153 | 17,954 |
| Abitibi district | 159,517 | 185,999 |
| Patricia district | 5,201 | 6,167 |
| St. Joseph district | 2,761 | 3,029 |
| Total | 1,793,238 | 1,954,083 |

tinued phenomenal growth in the distribution of power to the rural power districts. The peak of the rural demand which occurs in the month of August was 15 per cent higher in 1938 than the corresponding load of 1937.

The total load in December, 1938, for all co-operative systems and the Northern Ontario Properties, including both primary and secondary loads, reached 1,954,083 horsepower, the highest ever carried by the systems of the Commission, and 9.0 per cent above the December peak of 1937.

The accompanying tabulations give, for the months of October and De-

cember, 1937 and 1938, the primary peak loads of the co-operative systems and of the several districts of the Northern Ontario Properties. They also give similar data for the total primary and secondary loads.

### Reliability of Service

Year by year the demand for reliability and continuity of service grows more exacting, and this demand is equally insistent from the rural power districts and from the urban communities. Reliability of service depends upon many factors. Several sources of power, preferably situated in widely separated localities, are much less liable to be simultaneously affected than one or two sources of the same aggregate capacity. There must, of course, be adequate reserve capacity. A thoroughly co-ordinated and inter-connected transmission network equipped with modern relay and protective devices is necessary. But above all, there must be a consistent policy of insistence upon the highest standard of construction and maintenance. To cope with breakdowns, emergency trucks and line repair equipment under trained personnel, strategically placed, must at all times be ready for instant action.

It is gratifying to the Commission to be able to report that interruptions to service during the past year were almost negligible, both in extent and duration. The splendid service record obtained for all systems, with their dependence solely upon hydro-electric plants, is largely due to consistent adherence to policies established on sound underlying principles.

Contributing to reliability of service are the studies carried out by the testing and research laboratories of the Commission. The studies made in connection with the design, construction and operation of the systems have resulted in improvements of materials and methods of operation. The programme of continuous and systematic research is an important means of protecting the Commission's investments, since it helps to secure material and equipment of the highest quality, and to obtain from this equipment the maximum life and most efficient service.

### Additions to Generating Equipment

The Ragged Rapids development on the Musquash river about four miles below Bala was completed and came into service late in October, when an interesting opening ceremony was arranged to which representatives of the partner municipalities of the Georgian Bay system and others interested were invited.

The Ragged Rapids plant has a capacity of 10,000 horsepower and increases the total generating capacity available to the system to an amount approximating the present peak load demand. The power house contains two generating units, the turbine runners being of the Kaplan type with adjustable propeller blades which give a high efficiency at part loads.

Continuing the systematic programme of maintenance work on the power plants of the Wanapitei river, the timber dam on the Coniston development which was built in 1905 was replaced by a concrete structure.

Many generating stations of the Commission in Northern Ontario are

situated in isolated districts. Even those stations constructed to serve new mining districts are often of necessity far from the new towns and settlements associated with the mines. To retain the services of satisfactory operators at these generating plants it is desirable to provide accommodation that will make living in these out-of-the-way places as attractive as possible. During the past year or two the Commission has built additional houses at several stations in the Northern districts. Fourteen houses at Abitibi Canyon and seven at Ear Falls are practically completed. A number of houses and colony buildings are also being erected at Cameron Falls on the Nipigon river. Where considered advisable, schoolhouses, recreation rooms, stores, hospital and other buildings are included, and provision is made for water supply and electric service, sewage disposal and fire protection.

### Water Storage

In Northern Ontario an important water storage project was completed and brought into service. The project consists of a dam some fourteen miles below Connaught, which restores the level of Frederick House lake. This lake was drained twenty-nine years ago, and the new dam creates in it, and Night Hawk lake above it, a storage reservoir to augment the flow of the Abitibi river in periods of low water for the benefit of the Abitibi Canyon development. The dam was completed in time to impound the spring run-off of the Frederick House river. The project increases the dependable capacity of the Abitibi development by 40,000 horsepower.

Surveys for additional power development projects were made in various areas of Northern Ontario. On behalf of the Province the Commission completed the dams and other hydraulic works in connection with the Long Lac development scheme. This scheme comprises a dam north of Long Lac on the Kenogami river, a tributary of the Albany river, and a control dam and diversion channel south of Long lake. The immediate function of the work is to make possible the economical transportation to lake Superior of pulpwood from an area tributary to Long lake and the Kenogami river. If it is desirable later, these works will permit the diversion of water from this watershed to lake Superior. This diversion, however, would require international agreement.

### Purchased Power

At the beginning of the fiscal year with which this report deals, in November and December, 1937, a determined effort was made to bring to a satisfactory settlement the disputes with the Quebec power companies respecting the purchase of supplementary power supplies. As a result of discussion and negotiations new agreements were entered into with Gatineau Power Company, Maclaren-Quebec Power Company, and The Beauharnois Light, Heat and Power Company which it is believed are fair to the companies and satisfactory to the Commission. The termination of the unprofitable litigation was to both parties a major gain, effected by the new contracts. In addition, the

companies ended the uncertainty with respect to a market for their power, but, recognizing the changed conditions resulting from the long economic depression, agreed to a reduction in the price for power, and to a modification of certain other terms of the contracts.

During the past year the supplies of purchased power gave the Commission valuable and readily available power reserves. The necessity for such reserves was brought forcibly to attention by the terrific ice jam in the Niagara river, which, early in 1938, brought down the Falls View bridge, flooded the Ontario Power plant and disabled it for months, while at the same time the output of the Commission's other Niagara river generating stations was curtailed, so that the maximum simultaneous loss to the Commission in generating capacity approximated 255,000 horsepower. The settlement with the Quebec power companies was desirable and necessary, and, all things considered, the terms were favourable to the Commission. The following tabulation summarizes the power supplies arranged for under the new agreements.

*Gatineau Power Company and Gatineau Transmission Company:* 25-cycle power contract. Maximum supply 260,000 horsepower, to be supplied as follows—December 1, 1937, 165,000 horsepower; November 1, 1938, 200,000 horsepower; November 1, 1939, to November 30, 1970, 260,000 horsepower.

*Beauharnois Light, Heat and Power Company and Coteau Rapids Transmission Company, Limited:* Maximum supply 250,000 horsepower, to be supplied as follows—December 14, 1937, 125,000 horsepower; November 1, 1938, 150,000 horsepower; November 1, 1941, 200,000 horsepower; November 1, 1942, 225,000 horsepower; November 1, 1943, to November 1, 1976, 250,000 horsepower.

*Ottawa Valley Power Company:* This contract for 96,000 horsepower was unchanged.

*Maclaren-Quebec Power Company and The James Maclaren Company, Limited:* Maximum supply 100,000 horsepower to be supplied as follows—December 14, 1937, 40,000 horsepower; November 1, 1938, 60,000 horsepower; November 1, 1940, 80,000 horsepower; November 1, 1944, to October 31, 1970, 100,000 horsepower.

*Gatineau Power Company and Gatineau Transmission Company:* 60-cycle power contract. Maximum supply 60,000 horsepower as follows—December 1, 1937, 42,000 horsepower; October 1, 1938, to November 30, 1970, 60,000 horsepower.

The Eastern Ontario system took delivery of the last block of 60-cycle power available under the Gatineau contract, namely, 18,000 horsepower, on October 1, 1938, and this power will take care of the 1939 increase in load and act as a reserve for the system.

### Increased Transmission and Distribution Equipment

The transmission and distribution facilities of the several systems were extended and strengthened in many districts. In the Niagara system the capacity of the Leaside transformer

station has been increased to 420,000 kv-a. by the installation of two 75,000-kv-a. banks of transformers. A double circuit 110,000-volt line was completed between the transformer stations at Leaside and Strachan Avenue, to give an additional tie from the eastern power sources into the Niagara system. Eight new distributing stations were installed throughout the system and in seventeen others the capacity was increased.

In the Georgian Bay system, in order to meet conditions which it was anticipated would arise with the completion of the new 10,000 horsepower development at Ragged Rapids, the transmission networks of the system had been substantially strengthened in 1937. It was only necessary to complete this work during 1938. Additional transformer capacity was installed at eleven distribution stations.

In the Eastern Ontario system much has already been accomplished in the direction of highly reliable inter-connections. Among the more recent additions are the Madawaska tie, in the form of a 33,000-volt transmission line from Carleton Place to Arnprior, and the 110,000-volt Chats Falls-Trenton line. The Madawaska tie has been valuable in two ways. First, it made available to the system as a whole the surplus capacity in the Calabogie plant, over and above the requirements of the Madawaska district. Second, it enabled the rest of the system to assist the Madawaska district for a period of four months in 1938, during which the Calabogie station was disabled owing to the damage of generators by lightning. The Chats Falls-Trenton line has greatly facilitated the transfer of power in connection with the operation of the Eastern Ontario system. During the past year four new distributing stations were installed, and the capacity of four others increased.

In the Thunder Bay system the 9,000-kv-a. Long Lac transformer station was completed for the supply of power to the mining companies in that area, and two new companies were served.

The growth of the mining load in Northern Ontario necessitated the installation of new transformer and distributing stations, and the enlargement of others with the installation of additional equipment in many cases.

In all of the systems of the Commission a total of more than 135 route miles of transmission lines were constructed, 8 miles of which were for operation at 110,000 volts.

### RURAL ELECTRICAL SERVICE

The rural construction programme undertaken by the Commission during the year 1938 exceeded by a substantial margin the record of 1937, which was the previous high mark. The rural primary lines approved for construction in 1938 approximated 2,660 miles to serve more than 14,000 additional customers. The previous records were 2,300 miles in 1937 and 1,894 miles in 1930. Most of these lines were actually constructed during the year, or were under construction at the year's end. Due to the exceptionally heavy programme a few lines approved in 1938 will not be completed until early in 1939.

Due chiefly to the lowering of the service charge and the reduced requirements respecting the number of consumers per mile of line, the extension of service in rural power districts has in the past two or three years shown phenomenal growth. At the present time there are approximately 15,800 miles of rural lines serving 100,000 consumers, distributed among nearly 500 municipalities, including townships and police villages.

The aggregate load supplied to all rural Hydro consumers in the Province indicates by its substantial increase a growing appreciation of electrical service and an ability to install equipment to utilize this service. The average load for 1937 amounted to 45,506 horsepower. This increased during the year 1938 to 53,383 horsepower, or an increase of 17.3 per cent during the year. The present intense interest in the extension of rural service promises to continue. It is expected that during the year 1939 the rural construction programme will continue at the same pace as that of the last few years.

### Capital Expenditures

The extensions to generating stations, transmission lines and distribution networks, storage works, etc., during the year, have required capital expenditure of $10,876,458.83.

### Sales Promotion

During the first two decades of the Hydro enterprise continuous rapid growth took place, stimulated by a succession of exceptional causes, terminating in the economic boom of the late twenty's. The chief problem of the Commission during the first twenty years of its existence was that of providing sufficient power to meet the ever-pressing demand. The economic depression ended this period and the return of better times finds the Commission with ample supplies of power secured for some years ahead. One of the problems facing the Commission at the present time, therefore, is to make known to all Ontario's citizens the nature of the benefits which they can derive from making the fullest possible use in domestic and industrial fields of the low-cost power now available.

For the past few years, therefore, the Commission has devoted more attention to the promotion of the use of electricity in the home, on the farm, and in commercial institutions. During 1938 various campaigns were carried on in co-operation with the municipal utilities and the manufacturers of electrical equipment. Organization and advertising assistance was provided to the municipalities to conduct an electric range campaign, a water heater campaign, and a better lighting campaign, and the Commission conducted similar campaigns in the rural power districts.

The Commission plans to enlarge its activities in the promotional field, and has appointed a director of Sales Promotion, who is organizing a department to be responsible for advertising and promotional work. This department will form a co-ordinating medium uniting the efforts of the municipal Hydro utilities, The Hydro-Electric Power Commission and other branches of the electrical industry in the Province. By such united effort

the maximum results should be obtained.

### Capital Investment

The total investment of The Hydro-Electric Power Commission of Ontario in power undertakings and hydro-electric railways is $314,768,-081.30 exclusive of government grants in respect of construction of rural power districts' lines ($14,149,-666.86); and the investment of the municipalities in distributing systems and other assets is $122,053,495.27, making in power and hydro-electric railway undertakings a total investment of $436,821,576.57.

### Reserves of Commission and Municipal Electric Utilities

The total reserves of the Commission and the municipal electric utilities for depreciation, contingencies, stabilization of rates, sinking fund and insurance purposes amount to $200,103,382.07.

### Financial Operating Results For 1938

During the fiscal year 1938 the interim rates per horsepower, which are set by the Commission as a basis for the monthly levies towards the total cost of power as determined at the end of the year, remained at their lowered level. It will be recalled that in August, 1937, on the Niagara and Eastern Ontario systems, a substantial reduction was made in the interim rate to municipalities. This reduction in the interim rate was continued throughout the year 1938.

The revenue in 1938, therefore, reflects the fact that for the first nine months of the year rates to municipalities of the Niagara and Eastern Ontario systems were lower than in the corresponding months of 1937. This reduction in revenue to The Hydro-Electric Power Commission of Ontario by reason of reduced rates, involves, of course, no actual loss to consumers. On the contrary, the decrease in revenue to the Commission represents a gain to the Niagara system utilities which is ultimately passed on the consumers, in lower rates or in other ways.

The industrial recession in the United States had a marked effect in the later months of the year upon the Commission's sales of power to large electro-chemical and electro-metallurgical companies in the Niagara area, resulting in substantial curtailment of revenue compared with what earlier had been indicated as probable from this source.

During the fiscal year there was an increase of two million dollars in the cost of purchased power from the Quebec contracts settlement. This, of course, was foreseen when the agreements were revised. Notwithstanding this increase in Niagara system expenses and decrease in revenue in 1938, the Commission was able to set up the full sinking fund requirement, and normal depreciation after meeting all operating, maintenance and interest expenses. The amount contributed to the contingencies reserve was also approximately the same as in 1937. During 1937 two and one-third million dollars were set up in a rate stabilization reserve. In 1938 no contribution from revenue has been made to this reserve in the Niagara system. At the present time, however, the Commission has over four and a half million dollars in

its Niagara system rate stabilization fund. This fund was created for the purpose of stabilizing rates and differs from other reserves in that it is not augmented year by year and every year regardless of the conditions which led to its creation. The significant fact with respect to 1938 operations is that there has been no withdrawal from the rate stabilization fund.

The year's operations on the other systems of the Commission and the amounts placed to reserves were satisfactory. After meeting all operating expenses the Commission added to its financial reserves, including those for the Northern Ontario Properties, insurance, workmen's compensation and staff pension provisions, the sum of about eleven million dollars.

REVENUE OF COMMISSION

The revenue of the Commission at interim rates from the municipal utilities operating under cost contracts, from customers in rural power districts and from other customers with whom—on behalf of the municipalities—the Commission has special contracts, all within the Niagara, Georgian Bay, Eastern Ontario and Thunder Bay systems, Manitoulin Island and Nipissing rural power districts aggregates \$30,620,707.51. The revenue of the Commission from customers served by the Northern Ontario Properties, which are held and operated in trust for the Province, is \$3,402,958.84, making a total of \$34,023,666.35.

MUNICIPAL ELECTRIC UTILITIES

The following is a summation of the year's operation of the local electric utilities conducted by municipalities receiving power under cost contracts with the Commission:

| | | |
|---|---|---|
| Total revenue collected by the municipal electric utilities | | \$33,981,832.73 |
| Cost of power | \$20,575,457.95 | |
| Operation, maintenance and administration | 5,842,714.89 | |
| Interest | 1,642,663.25 | |
| Sinking fund and principal payments on debentures | 2,424,098.70 | |
| Depreciation and other reserves | 2,451,529.46 | |
| Total | | 32,936,464.25 |
| Surplus | | 1,045,368.48 |

With regard to the local Hydro utilities operating under cost contracts, the following statements summarize for each of the four co-operative systems administered by the Commission, the financial status and the year's operations.

NIAGARA SYSTEM

The total plant assets of the Niagara system utilities amount to \$83,001,844.87. The total assets, including an equity in the H-E.P.C. of \$38,546,153.06 aggregate \$141,134,310.55. The reserves and surplus accumulated in connection with the local utilities, exclusive of the equity in the H-E.P.C., amount to \$69,341,857.12, an increase of \$4,235,812.60 during the year 1938. The percentage of net debt to total assets is 24.4, a reduction of 2.9 per cent.

The total revenue of the municipal electric utilities served by this system was $27,567,836.78, a decrease of $87,388.18, as compared with the previous year. After meeting all expenses in respect of operation, including interest, setting up the standard depreciation reserve amounting to $2,003,615.43 and providing $2.242,-798.84 for the retirement of instalment and sinking fund debentures, the total net surplus for the year for the municipal electric utilities served by the Niagara system amounted to $655,157.82, as compared with $998,-132.08 the previous year.

### GEORGIAN BAY SYSTEM

The total plant assets of the Georgian Bay system utilities amount to $2,907,381.17. The total assets, including an equity in the H-E.P.C. of $1,421,198.47 aggregate $4,951,-555.31. The reserves and surplus accumulated in connection with the local utilities, exclusive of the equity in H-E.P.C., amount to $3,087,587.69, an increase of $140,669.80 during the year 1938. The percentage of the net debt to total assets is 12.3, a reduction of 1.6 per cent.

The total revenue of the municipal electric utilities served by this system was $1,240,089.71, an increase of $25,202.30 as compared with the previous year. After meeting all expenses in respect of operation, including interest, setting up the standard depreciation reserve amounting to $87,698.08 and providing $47,-943.38 for the retirement of instalment and sinking fund debentures, the total net surplus for the year for the municipal electric utilities served by the Georgian Bay system amounted to $75,450.57 as compared with $48,756.13 the previous year.

### EASTERN ONTARIO SYSTEM

The total plant assets of the Eastern Ontario system utilities amount to $8,789,985.03. The total assets, including an equity in the H-E.P.C. of $1,956,360.34, aggregate $13,180,818.-72. The reserves and surplus accumulated in connection with the local utilities, exclusive of the equity in H-E.P.C., amount to $9,102,617.17, an increase of $571,908.72 during the year 1938. The percentage of net debt to total assets is 12.3, a reduction of 1.7 per cent.

The total revenue of the municipal electric utilities served by this system was $3,536,559.56, a decrease of $28,937.31 as compared with the previous year. After meeting all expenses in respect of operation, including interest, setting up the standard depreciation reserve amounting to $226,373.00 and providing $106,-983.15 for the retirement of instalment and sinking fund debentures, the total net surplus for the year for the municipal electric utilities served by the Eastern Ontario system amounted to $243,365.46 as compared with $290,449.54 the previous year.

### THUNDER BAY SYSTEM

The total plant assets of the Thunder Bay system utilities amount to $2,726,465.75. The total assets, including an equity in the H-E.P.C. of $2,330,406.77, aggregate $6,220,-833.02. The reserves and surplus accumulated in connection with the local utilities, exclusive of the equity in H-E.P.C., amount to $3,350,233.84, a decrease of $17,248.22 during the

year 1938. The percentage of net debt to total assets is 9.5, an increase of 0.1 per cent.

The total revenue of the municipal electric utilities served by this system was $1,179,175.59, a decrease of $136,755.81 as compared with the previous year. After meeting all expenses in respect of operation, including interest, setting up the standard depreciation reserve amounting to $43,891.34 and providing $11,093.64 for the retirement of instalment and sinking fund debentures, the total net loss for the year for the municipal electric utilities served by the Thunder Bay system amounted to $16,900.17, as compared with a net surplus of $64,835.16 for the previous year.

# Tide Mills in Great Britain

THE enormous amount of energy available in the flow and ebb of the tide appears to have attracted attention very early in the history of Great Britain judging by the number of old tide mills which are still to be found either complete or in a ruinous condition. A systematic attempt to collect information about these mills was made by Rex Wailes, and as a result presented a considerable amount of data at a meeting of the Newcomen Society, held at the Institution of Civil Engineers on Wednesday, October 12th, 1938. A summary of the material given in the paper appeared in *Engineering* from which we have abstracted some of the details and comments.

During two years' work in the field Mr. Wailes had discovered 23 tide mills of which ten were still worked by the tide, two were working by power, five were used for other purposes and six stood derelict, with some of the machinery still in place. In addition there were a number of tide mill sites to be found, several cases where the outbuildings remained though the mill itself had disappeared, while there were numerous references to tide mills of which no trace remained.

Neglecting the case of mills no longer visible, the first mill considered in the account is that at Woodbridge on the Deben estuary, Suffolk. The records of this mill extend as far back as about the year 1170, while later mention is dated 1564, when the mill was granted by Queen Elizabeth to Thomas Seckford. The mill stands on a quay beside a power mill and is served by a pond having an area of 3,100,000 square feet and providing a head of 6 ft. The wheel is in a small wheel house outside the mill, and was renewed in 1932. It is of wood throughout and is 20 feet in diameter by 5 feet 10 inches wide. The shaft is of oak and is 22 inches square. The method of operation varies with the level of the impounded water. A vertical penstock is first raised to allow the water to flow over the sluice, the

wheel being then breast-shot. The sluice consists of two horizontal sections. On the fall of the water the top half is raised about 12 inches. Later, the bottom section is raised and the wheel is undershot. The wheel drives four pairs of stones on the first floor, all of which are controlled by a single pair of governors driven from the upright shaft, which is of oak and 22 inches in diameter.

That at the head of St. Osyth creek, Essex, was worked down to 1930. It belonged to St. Osyth's Abbey, and is mentioned in the monastic balance sheet of 1491. The existing building, however, according to A. R. Powys, dates from about 1730. It is weatherboarded and tiled and is built on a bridge. The pond is about 30 acres in extent. There are two wheels 18 feet 6 inches in diameter by 6 feet wide which drove two groups of three and four pairs of stones. At the head of Arlesford creek, is a disused mill with a wheel of the outside breast-shot type, with closed buckets, being of iron mounted on an iron shaft. Another on Roman river retains its 16 ft. diameter closed-bucket breast-wheel. Near Roachford on the Roach, is a mill still at work. The wheel is about 18 feet in diameter by 12 feet 9 inches wide and has wooden floats. It is mounted on a wooden shaft and drives three pairs of stones.

At Bromley-by-Bow, east of London, are two mills whose history goes back to 1135. Of the two mills the older was rebuilt in 1776 and has four wheels about 20 feet in diameter. The width of three varies from 3 ft. to 3 ft. 5½ inches and each develops from 20 to 25 horsepower. The fourth wheel, also 20 feet in diameter, is considerably wider and develops 40 to 45 horsepower. They drive 12 pairs of stones. The other mill was re-built in 1817 and has three wheels all about 20 feet in diameter and varying in width from 2 feet 7 inches to 4 feet. Each develops 20 to 25 horsepower. They all have Poncelet floats and drive six pairs of stones.

A mill at Strood, Kent, was in operation up to 1858 at which time it was between 200 and 300 years old. Two wheels, on either side of a flap sluice, drove five pairs of stones, flour dressers, wheat cleaners and the sack hoist. The output was 50 sacks a week. With a spring tide it would run for 6 hours. With an ordinary tide, three hours had to elapse after high tide before the mill could work, and it could not work at all with a neap tide or if the wind held up the water.

A mill at the mouth of the Chichester canal in Sussex was working up to 1935. It had two wheels and was served by a 30 acre pond giving a normal head of 12 feet and a working period of 5½ hours.

On the river Test, at Eling, a tide mill stands on a toll bridge. The automatic tide gates are incorporated in four hand-operated sluices built on to the upstream side of the bridge. The tide is admitted by flap valves instead of by lock-type gates, as is usual. The head is about 12 feet, and at spring tides the river fills up for two miles back. There are two iron water wheels 11 feet 6 inches in diameter by 5 feet 2 inches wide, with 24 curved Poncelet floats. With the

exception of the great spur wheel, which is of iron and cogged, all the shafts and gears are of iron.

In the Isle of Wight, two working installations are referred to. One of these has a single wheel 15 feet 6 inches in diameter by 6 feet 8 inches wide and has 30 floats of oak. It is mounted on a 12 inch octagonal shaft and now drives two pairs of composite stones, the third pair having been removed. The other installation has two wheels about 24 feet in diameter by 6 feet wide, although only one is in use. It can drive three pairs of stones. An attempt to work one set of gears by gas engine in conjunction with the water wheel failed on account of the effect of the hit-and-miss governor of the engine. The mill is fed by Blackbrook brook as well as by the tide, and has both lock-gate type and flap-valve sluices on the upstream side of the bridge. It will work the wheel for four hours each normal tide.

At Anthony in Cornwall there is a mill that was closed down in 1915 having a single undershot wheel 7 feet 6 inches in diameter by 3 feet wide on a wooden shaft 18 inches in diameter, which drove two pairs of stones. Gear and pinion work in this mill is of wood. Another near the same location which has been out of use since about 1880 has four wooden wheels about 12 feet in diameter by 3 feet wide, mounted on shafts about 12 inches in diameter. Each wheel drove one pair of stones. The water was impounded in a pond of 8½ acres.

Of the two mills working in Pembrokeshire, one at Pembroke itself probably replaced an earlier mill. The water wheel is of the undershot type and is of wood and iron with wooden buckets. It is 20 feet in diameter by 12 feet wide and is mounted on an iron shaft 9 inches square. The pond is one mile long by about 150 yards wide and is fed by fresh, as well as tidal, water. When full the head is nearly 12 feet. Another mill 6 miles from Pembroke is also semi-tidal and has a pond of 25 to 30 acres, giving a head of 11 feet. There are two undershot wheels of wood and iron 16 feet in diameter, one being 5 feet 6 inches and the other 7 feet wide on 9 inch square shafts. Each drives three pairs of stones.

The data submitted show that there are four main methods of wheel construction, viz.: wooden wheels with radiating arms, wooden wheels with arms tangential to the hub, wheels made with wooden arms and iron hubs and all-iron wheels. Some wheels have wooden buckets; some straight wood floats and, on wheels which are made wholly of iron Poncelet floats. The wood shafts vary from 12 inches octagonal to 24 inches square and are invariably of oak. The iron shafts vary from 6 inches square to 12 inches in diameter. The vertical shafts also vary. The largest wooden one is of oak, 28 inches in diameter and the smallest, which is multangular, 15 inches across the flats and of pitch-pine.

Regarding details of working other than those mentioned above, it was stated that one mill was closed as it was impossible to obtain men who would work at the variable times due to the daily changing of tidal periods.

# Safety Lighting In Cities

By Earl J. Reeder, Chief Traffic Engineer, National Safety Council

THE year 1938 saw a substantial reduction from the all-time peak in traffic accidents which occurred the previous year. That has been the cause of much satisfaction on the part of public officials and others for it demonstrates that there need not be a rising toll of traffic accidents year after year and that substantial reductions are possible.

An important fact that remains as a serious challenge to the interest and responsibility of public officials is that the traffic accident problem is particularly acute at night. It is then that nearly two-thirds of the fatalities occur in cities while less than one-third of the traffic is on the streets.

One thing that makes the traffic accident problem particularly bad at night is that pedestrians are especially susceptible to accidents after dark and the pedestrian accident problem is a major part of the total for the twenty-four hours. This fact has an important part in determining the need for safety lighting in different parts of an urban area.

So far, the outstanding evidence of the success of safety street lighting has been in the prevention of pedestrian accidents. Studies made by the Committee on Night Traffic Hazards of the National Safety Council's Street and Highway Traffic Section have shown that pedestrians have been the greatest beneficiaries in the installations studied in Detroit, Dallas, Syracuse, and other places. This is as one might expect because pedestrians very seldom carry a light and often their clothing reflects very little of the light from headlamps. Hence, they are apt to assume that drivers can see them whenever they can see the drivers' headlights. However, that is far from true and when relying upon such an assumption the pedestrian is apt inadvertently to put himself in a most dangerous position if he must depend alone upon the headlights of motor vehicles for his protection.

Special illumination of boulevards and other busy streets in the better parts of cities is not uncommon. This often is prompted by the desire for beautification of such streets and for crime prevention in areas of higher social and economic status. However, studies by the National Safety Council's Committee on Pedestrian Control and Protection have shown that pedestrian accidents are nearly always most frequent in areas of lower social and economic status. It is there that, too frequently, street lighting is neglected or sub-standard lighting is installed, considering only the social and economic side of the question and overlooking the safety of human lives. When we install lighting for safety we should do so where the night accident problem is most acute, regardless of the social or economic status.

In recent years there has been a

*Excellent for horse-and-buggy traffic but almost worse than none for modern speeds, this poorly lighted street jeopardizes the lives of both driver and pedestrian.*

vast change in the conception of what constitutes good lighting, a change made necessary by the growing seriousness of the night accident problem. No longer is lighting evaluated alone in terms of the number of luminaires per mile or even the intensity of light per unit. Instead, safety lighting means the proper spacing of luminaires in relation to their height and the proper direction of the light upon the streets and their adjacent walks.

In approaching the question of "What is Good Lighting?" we must remember that seeing upon a street by night is entirely different from seeing by day. In the daytime the light from the sun is greatly diffused owing to the reflection of the intense rays upon many particles in the air and upon various objects. There is no better indication of this than the fact that one can see to read easily in the shade of a tree or building although the direct rays of the sun do not reach him.

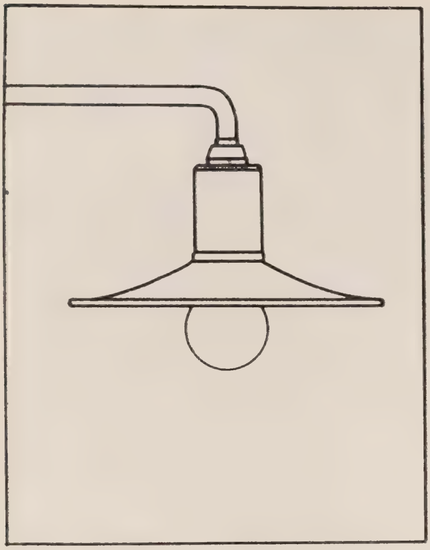
At night, however, objects upon the street are mainly illuminated by local sources of light. If one looks at the side of an object opposite a source of light at night he sees little except the dark shape of the object because lighting isn't sufficiently general to approach daylight conditions. In other words, he sees the object in silhouette. A good way to test this is to watch carefully how you see an object ahead of you as you drive at night on a lighted street. In most cases you will see the object by silhouette against the pavement surface

*As a result of modernizing safety lighting this town, and many other cities, are drastically cutting nighttime accidents, saving thousands of dollars and scores of lives annually.*

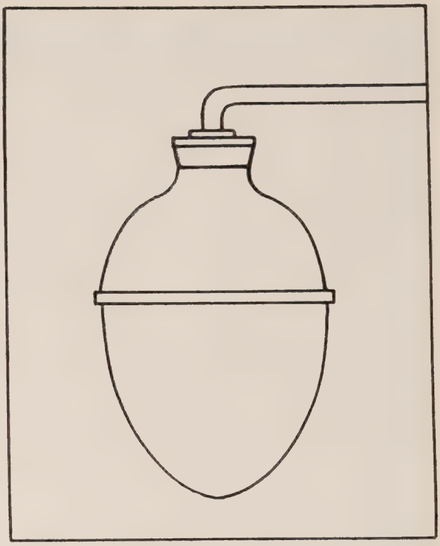
that is illuminated by a street light ahead. You will see very few surface details, if any. That is the primary purpose of good lighting and the lights should be installed to provide that kind of illumination and visibility, at the very least. The relation between the height of mountings and the spacing of luminaires should be such as to give a continuing condition of seeing by silhouette as one drives along the street. This means that some of the light from one luminaire should strike the pavement at least as far away as the next luminaire.

The day of illuminating the tree-tops and building fronts by lights along the street is rapidly passing in favour of lighting that is well-directed at the pavement surface and the adjacent sidewalks. Many a system of lights perched on the tops of poles along the street, dissipating the light up into the air, accomplishes little more than to show the drivers a line of poles which shouldn't be hit. It does not provide a well-lighted pavement surface against which objects stand out clearly in silhouette. Good lighting requires luminaires that allow little light to escape toward unimportant objects above or away from the street. There have been some good examples of lighting systems in which better direction of the light combined with improved spacing and mounting heights have increased the surface brightness of the pavement with no greater current consumption.

Safety lighting ought to be installed where the ratio of night to day accidents is high and shows that the usual methods of illumination—head-



*Reminiscent of the old fashioned arc light, this luminaire is rapidly becoming obsolete. It is being superseded by* ⋙→



*The streamlined luminaire. More modern in appearance, it gives better light distribution in addition to reducing glare.*

lamps, reflectorized signs, and similar measures—are not adequate for protection. In the recent traffic studies in Cleveland, Ohio, where the writer served as consultant, a study of day and night accidents was made for 43 miles of streets with various types of lighting. The number of night accidents in the section having the best lighting was about equal to the number of day accidents. On the streets with the next best lights night accidents were three times those during the day and on the third type the ratio was four at night to one in the day time.

In Detroit substantial evidence of the value of improved lighting for street safety has followed the installation of some 31 miles of such improvements. The ratio of night to day traffic fatalities was reduced from 6.9 to 1 to 1.5 to 1. By far the largest part of this reduction was in night pedestrian fatalities.

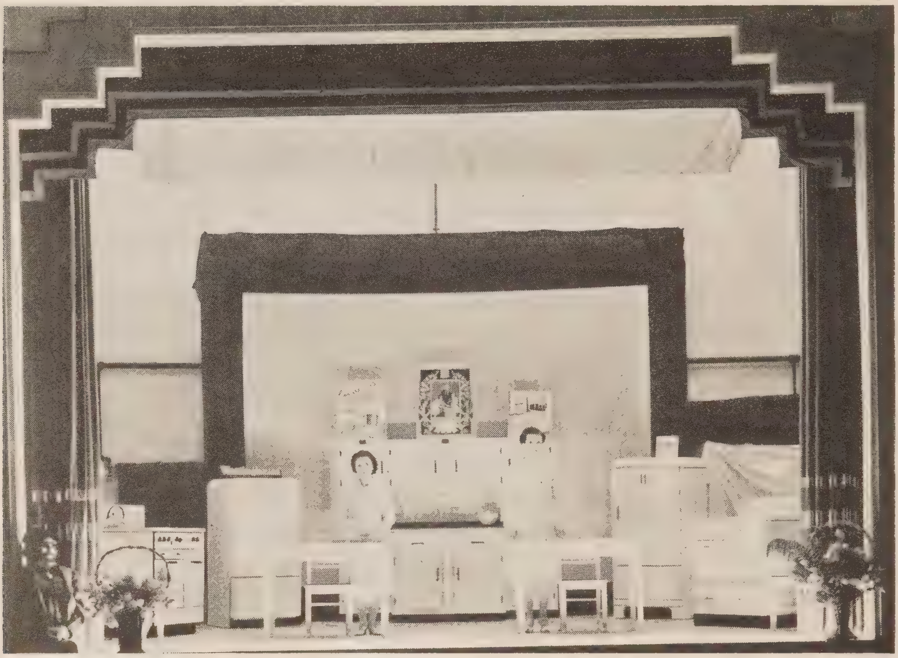
There are other reasons for street lighting than the prevention of accidents. Its value for beautification and crime prevention along city streets and suburban roads cannot be denied. However, wherever lighting is installed it should be made adequate first for traffic safety and these other features can be served as "plus" values. In other words, any city lighting installation should provide sufficient light for traffic safety from luminaires properly spaced and mounted with the light directed largely at the pavement surface. More lights can then be added if desired for other purposes but they should not be so installed as to conflict with the purpose of lighting for safety.

While the improvements of lighting on existing city streets is a matter that must proceed on a selective basis, attacking those zones with the highest ratio of night to day accidents first, every new design and construction of streets should include adequate provision for safety lighting. In the original design and construction the posts can be properly spaced to give the best pavement brightness. Sometimes this is not as readily possible in subsequent installations. If the improvement is in a business district or is likely to carry heavy traffic and have numerous pedestrians, it is necessary to go farther than sufficient spacing and direction for seeing by silhouette, by providing additional lights for seeing by reflection also. This requirement occurs when traffic is so dense that the pavement surface is not adequately visible ahead to provide seeing by silhouette and more general lighting is provided.

Whenever a city street is to be lighted records of accidents should be assembled for a sufficient time before the installation to make possible a convincing comparison with similar records taken afterwards. Similar "before and after" records should be made concerning the volumes of traffic, speeds, numbers of pedestrians, and other information which will be valuable in showing the effect of lighting upon traffic movement and safety.

It is not sufficient to record merely the number of accidents. A complete analysis should be made of the types of accidents that have occurred before and after a change and of the specific locations where they occur. This adds to the total of information concerning the types of accidents which street lighting will prevent and helps to arm public officials for the proper decisions concerning installation. This is the type of information that is needed by such organizations as the National Safety Council's Committee on Night Traffic Hazards, to supplement the data that have been gathered so far. It will increase the evidence concerning the real values of street lighting and will greatly aid in the future policies of lighting improvements.

Night traffic safety is one of the major responsibilities of public officials. Even more than that, it is one of the best opportunities for them to render an outstanding service to the people of their communities. It is a service expressed in terms of lives and properly protected at the same time that convenience and comfort in driving and walking are provided.—*Illinois Municipal Review.*



# Chesley Cooking School

ON Tuesday and Wednesday, May 30th and 31st, a very successful cooking school was held in Chesley, sponsored by the Chesley Public Utilities Commission, the Women's Institute and the local electrical dealers. The theatre, where the school was held, was filled to capacity each day and the demonstration and display of modern electrical appliances was highly spoken of by everyone.

The school was opened by C. J. Halliday, Chairman of the Public Utilities Commission, who introduced the demonstrators. Diversity was added to the program by stage entertainment and a fashion show. Attendance prizes were drawn each day, tickets for which were sold at 10 cents each. These prizes, eighteen in all, were three electrical appliances each day and six articles of food prepared in each afternoon's demonstrations. A total of 780 tickets were purchased.

With the cooking school, Chesley Public Utilities Commission began a range campaign which is to last for six weeks. This is being conducted in co-operation with the range campaign of the Hydro-Electric Power Commission of Ontario and each purchase of a new standard electric range from any local dealer will receive a cash rebate of $30.00.

# Ground Line Preservation of Wood Poles

*The following new specification 381012 for ground line treatment of wood poles embodying changes resulting from our experience has been issued superseding specification 360630 published as Appendix I in the March, 1937, Bulletin.*—EDITOR.

THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO
SPECIFICATION 381012 SUPERSEDING 360630 FOR
INSTALLATION OF SAND CREOSOTE COLLAR FOR GROUND LINE
PROTECTION OF POLES

## INTRODUCTION

The strength of a pole is largely determined by the amount of sound wood at, or just below, the ground line. It is therefore important that the timber at this point be preserved in its original state as long as possible.

Rot first begins at the ground line of a pole set in soil and rapidly progresses downwards a foot or two and inward through the sapwood into the heart-wood unless means are taken to preserve the wood at this vulnerable point.

Experiments have shown that creosote oil is an effective and economical preservative agent for wood under these conditions. This specification describes the sand-creosote collar which is now standard for ground line treatment of Commission poles.

## INSTRUCTION FOR THE SAND CREOSOTE COLLAR

The sand creosote collar and the method of applying it are described below:

*(a) Material Required per Unit*

| Quantity | Item |
|---|---|
| 1 sheet | Specially galvanized sheet iron 18 in. wide and about a foot longer than the circumference of the pole or stub at the ground line. The following standard lengths will be carried in stock 3 ft. 6 in., 4 ft., 4 ft. 6 in. and 5 ft. These sheets are No. 28 gauge, galvanized to grade B of the ASTM Specification No. A93-27 with a minimum zinc coating of 1.8 oz. instead of the standard 1.75 oz.<br>Where large poles are encountered, requiring a longer piece, the extra length may be sheared from a short sheet. |
| 1 piece | Aluminum or soft copper tie wire not smaller than No. 10 B & S gauge—4 ft. to 5½ ft. long, or removable tie as described under tools. |
| 1 | Wooden spacing wedge (permanent) clear pine, 1¼ in. by 1¼ in. by 16 in. tapering to a 5/32 in. by 1¼ in. edge. |
| 2 | 3½ in. No. 9 s.w.g. wire nails. |

| | |
|---|---|
| 2 to 3 gals. | Fine sand sufficiently dry to flow freely. The sand must be composed of multi-sized grains and it should be considerably finer than that used in mortar or cement, otherwise it will not retain sufficient creosote. It must be sufficiently dry to flow freely because moist sand cannot be properly compacted in the collar. |

As the composition of the sand must be such that it will retain the required amount of creosote it shall be tested in accordance with the undernoted:

A section of 6 in. stove pipe or 3 in. to 4 in. drain pipe having a length of not less than 18 in. shall be stood on end on a flat concrete or iron surface. In this pipe the proposed filler shall be tamped to a depth of approximately 15 in. On top of the filler creosote shall be poured to a depth of about 3 in. The specimen under test shall then be left undisturbed for at least 10 hours at normal room temperature, and if there is no appreciable leakage of creosote around the bottom of the pipe the filler is suitable for use in the collar. If there is any considerable leakage of creosote, the filler is unsuitable and it shall not be used.

| | |
|---|---|
| 1 gal. (approx.) | Approved creosote oil. |

*(b) Tools Required*

In addition to the above mentioned materials, special tools will be required consisting of:

| Quantity | Item |
|---|---|
| 6 to 8 | Armoured wooden wedges (as per sketch attached) containers for handling the creosote and sand, pliers, snips, hammer, round nose garden trowel, hand screen, shovels and tamping bar. |
| 1 | Removable tie consisting of a 9/16 in. dia. by 4⅜ in. by No. 14 s.w.g. close wound steel spring, or its equivalent, fastened to a 5 ft. 6 in. length of sash chain (1¾ oz.) ending with a holding pin. |

*(c) No Collars to be Installed When the Temperature is Below 40 deg. fahr.*

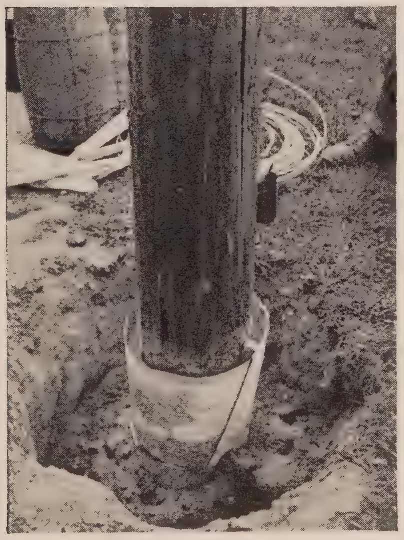
Below 40 deg. fahr. creosote oil becomes so viscous that it is not readily absorbed by the filler or the pole. Collars shall not be installed, therefore when the temperature is below 40 deg. fahr.

*(d) Preparing the Pole for the Collar*

Poles and stubs that are being erected shall be back-filled to within 18 in. of the ground level, and all the earth cleaned off the pole above this point. On standing poles and stubs that are to be equipped with the collar, the earth shall be excavated for a width of 9 in. around the butt and to the depth of the rot. All surface rot shall be cleaned off, and all sap wood with underlying decay shall be remov-

*Sheet of galvanized iron wrapped around pole and tied with aluminum tie wire.*

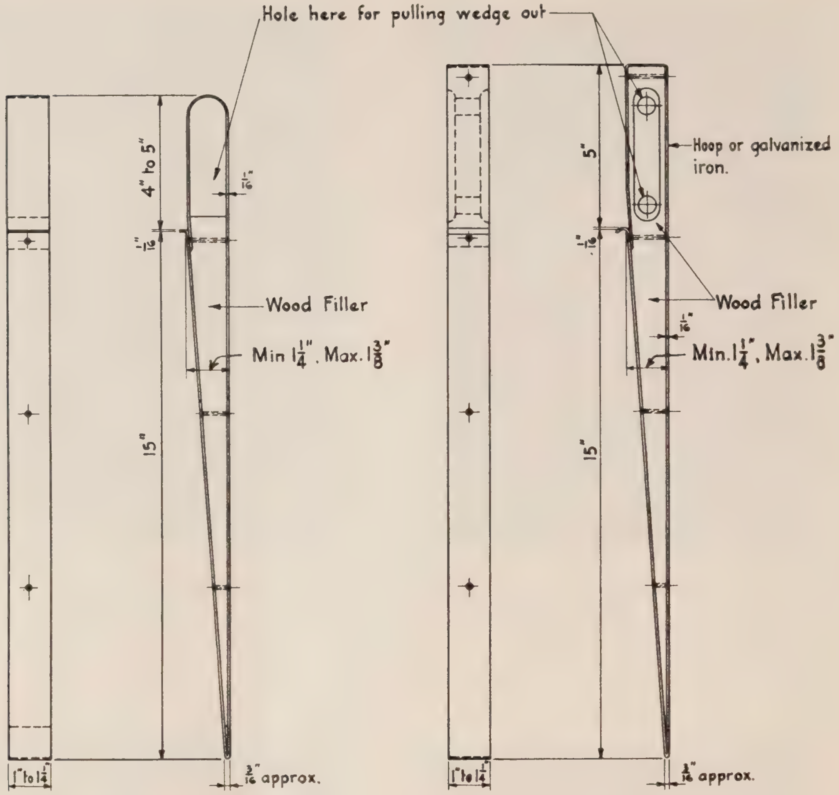
*Collar lowered to position, wedges placed and partly filled with sand.*



*Temporary wedges removed.*

*Sand-creosote collar installed ready for the back-filling operation.*

*Sand-Creosote Collar.*




Note:

If hoop iron is used, chamfer edges to avoid cutting galvanizing.

These wedges may be made locally.
The above designs are only suggestions, and may be modified where desirable.

DESIGN SUGGESTIONS FOR ARMOURED WEDGES FOR USE WITH THE SAND—CREOSOTE COLLAR

Operating Dept. Toronto. April 23.36. T.F.C.

ed, using a 3 in. carpenter's slick or other similar approved tool. Rot underlying the sapwood is not always apparent from the outside of the pole and in order to check this, a part of the sapwood shall be shaved off at two or more points around the pole. The hole shall then be back-filled and tamped to about 18 in. from the ground line.

*(e) Reinforcing Low Strength Poles.*

All poles or stubs showing decay must be measured and the strength determined in accordance with Instruction H.O.-159-F3 immediately after they are opened up and the rot cleaned off. If in the opinion of the foreman the remaining strength of any pole is too low for safe operation it should be temporarily guyed or immediately reinforced in accordance with Instruction H.O.-180-F3 and reported to the District Office in the required manner.

*(f) Drying Period*

After removing the rot the pole or stub shall be left exposed at least one week in order that it may dry out; this shall also apply to a new pole or stub that has not been equipped with a collar at the time of installation.

Considerable time and expense can be saved by equipping all new poles and stubs with collars immediately after erection and before the wood has had an opportunity to absorb moisture from the surrounding earth.

*(g) Installing the Collar*

1. The galvanized sheet shall be wrapped around the pole at a convenient height, and drawn up to an average distance of ½ in. from the surface of the pole by the tie.
2. The tied sheet shall be lowered into the hole until the top is 1 in. above the ground level, and the tie slipped down to 4 or 5 in. from the bottom of the sheet.
   (a) The collar should be kept clear of the bottom of the hole so that soil will not interfere with the lower edge of the sheet closing tightly around the pole.
   (b) On all poles carrying covered ground wires from equipment or neutrals the moulding must be carried down inside the collar and the collar must be kept clear of the ground wires at the bottom in an approved manner as it is not considered to be a part of the grounding system.
3. The permanent wooden spacing wedge shall be pushed, point first, down between the iron sheet and the pole at the centre of the overlap until the top of the wedge is flush with the top of the sheet.
4. Six or eight temporary (armoured) wedges shall be inserted in a similar manner between the iron sheet and the pole, and equally spaced around the pole. This must draw the lower edge of the sheet tightly to the pole surface and force the top edge about 1¼ in. away from the pole; thus providing a cone-shaped container surrounding the pole at the ground line and below. If a close fit is not obtained the tie should be either raised or tightened. If pole is irregular at the bottom, the iron sheet should be hammered into the depression.
5. Two 3½ in. nails shall be driven through the iron sheet and permanent wedge into the pole, starting the first near the top of the sheet and the other 6 in. below it.
6. The top corners of the iron sheet, where they project over the top edge, shall be bent down over the sheet, so as to lock it.
7. About 4 in. of the soil shall be

thrown into the hole surrounding the collar, and tamped.

8. The collar shall be filled with dry sand as noted in (a): The temporary wedges shall then be removed by lifting them in small increments and forcing them down after each lift to consolidate the sand in the lower portion of the collar. It is particularly important that this be done to eliminate any "Pipes" or voids in the filler since these are liable to cause drainage of some of the creosote through the bottom of the collar.

   When all the temporary wedges have been removed, the collar shall be filled and tamped to within 4½ in. on old poles and stubs, and 3½ in. on new poles and stubs, from the low side of the collar and levelled off. By levelling the filler an even depth of creosote and an even absorption is obtained all around the pole.

9. Creosote shall be poured in top of the collar to a depth of 4 in. on old poles or stubs and 3 in. on new, and while this is being absorbed by the filler, the back-filling shall be completed and thoroughly tamped.

10. The collar shall be left for 2½ hours to allow the creosote to penetrate to the bottom of the filler. The top of the collar shall then be filled with a saturated mixture of sand and creosote, and bevelled off so as to shed rain.

The installation is then complete.

# Hydro Travel Shop

EARLY in February the Travel Shop was fully equipped and ready for the road, but owing to weather conditions it was not deemed advisable to start on any predetermined schedule. However, good use was made of it in the meantime by displaying it at the A.M.E.U. Convention, various Agricultural Conventions, Seed Fairs, and Ontario Agricultural College at Guelph, as well as in the market places of several of the larger municipalities. During this time over 6,000 persons viewed the equipment.

In April, with a full equipment and staff, the coach started out on a regular schedule of calls throughout the western part of the province, for the benefit of both municipal Hydro systems and rural power districts.

The usual routine is to place the coach in a prominent location, as close as possible to a suitable hall or auditorium. A cooking demonstration is usually held in the afternoon and an electric equipment and better lighting demonstration in the evening. The local Hydro officials are usually requested to outline the Hydro policies with regard to appliance merchandising, rates and any special offers to purchasers of electric load building equipment. Attendance prizes, entertainment and com-

munity singing are also features of each session.

Since April 1st over 30 municipalities have enjoyed the visits and activities of the Travel Shop and over 10,000 people have attended the demonstrations.

In all the municipalities and rural power districts visited the audiences displayed keen interest and the activity has stimulated the sale of electrical equipment in these centres. The coach has proved an excellent means of securing many good prospects for electric appliances and service which are referred to the local dealers and Hydro for follow up.

The manufacturers have somewhat broadened out the activity by having their own display coaches and representatives tie in with the schedule of the travel coach and the resulting increase in sales has been beneficial to the whole electrical industry.

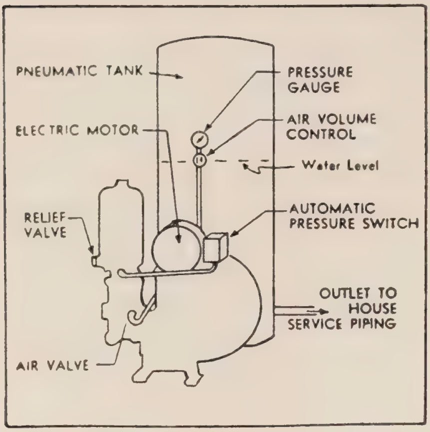
# Water Supply On The Farm

THE problem of water supply on the farm is one which, in the past, has caused considerable worry and anxiety to the farmer, especially in times of drought, but tremendous advances have been made in farm water systems in recent years. The modern supply system is entirely automatic and requires no attention beyond an occasional looking over to check up the mechanical condition of the plant, and periodical attention to lubrication.

When it is said that a supply system is automatic, no exaggeration is made, for a modern system will automatically maintain pressure of water at the outlet taps, start and stop the electric motor without human aid, lubricate itself and protect itself from damage due to excess of water pressure which may be caused by the failure of one of the automatic controllers.

There are two systems which come under the heading of automatic water supply systems, the simplest and oldest being the gravity system, by which is meant that an electrically-driven pump supplies the water to an overhead tank, which thereafter feeds the taps by gravity or pressure due to the height at which it is stored. In this case, a float switch is used to start the motor when the water level falls to a predetermined point, and stops the motor when the tank is full once more.

The second system is what we may call a "hydro-pneumatic" system, which consists of a motor-driven pump which feeds water into a closed container or pneumatic tank, in the top of which a cushion of air is trapped, and which is compressed as water is pumped into the tank. When a tap is opened, the air pressure above the water forces water out of the tap. This is a very important point as it makes the water supply system much more valuable in the unfortunate event of the premises catching fire.




*Showing the parts of a hydro-pneumatic water system.*

A large storage tank in the attic or on "stilts" outside the building provides a reserve of water in case of a breakdown of the pumping plant, but such a thing is an extreme rarity nowadays, as modern pumps are practically as reliable as electric motors, and that is saying a great deal. A tank which holds about fifty gallons will usually be found to tide over any such unfortunate occurrence, and this can be provided with a hydro-pneumatic system, a tank for which will cost less than a gravity tank and its supporting tower, as well as providing a pressure of between twenty and forty pounds against eleven pounds pressure given by a gravity tank mounted 25 ft. high.

In the case of the hydro-pneumatic tank, this can be situated in the pit with its pump and motor, and thus will be protected very considerably against possible damage by frost.

In choosing a pump for a water supply system, three factors must be considered:—

(a) Suction conditions. The nature of the well, whether deep or shallow, and the place where it is proposed to put the pump.

(b) The amount of water required, which will determine the size of the pump, and

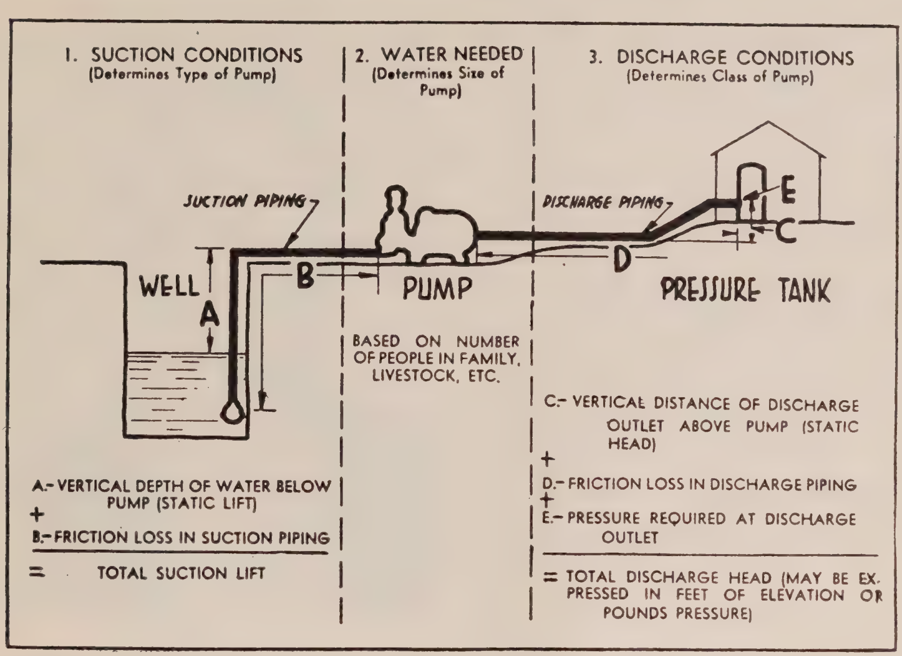
(c) Details of the outlets required, which will decide whether a low, medium or high pressure pump is necessary.

The shallow well pump is the most generally used type, and will lift water from up to—or rather down to—22 ft. In other words, if the water in the well falls to a depth greater than 22 ft. the pump ceases to work. Although often described as a suction pump, this type works by creating a partial vacuum into which the water is forced by the pressure of the atmosphere.

### Water Requirements

The volume of water required on the farm is a very important factor in the choice of a pump as well as in determining the size of the storage tank needed. When water is to be used for the purposes of the farm home only, it is only necessary to consider how many people there are in the family, but if the supply is to be used, as inevitably it will, for general farm purposes, then careful consideration must be given to the whole problem, and every likely use to which water may be put must be noted down and allowed for, in order that the system, once installed, shall not be found inadequate.

For each member of the family it will be necessary to allow 35 gallons a day, which will cover the requirements for cooking, washing up, bath,




*Three factors to consider in selecting an automatic water system. For calculating the size of the pump, the tables supplied by the manufacturers will be found useful.*

lavatory, laundry, and so on. Other requirements are:—

| | | |
|---|---|---|
| Each horse | 10 | gal. per day |
| " cow | 15 | " " " |
| " hog | 2 | " " " |
| " sheep | 1½ | " " " |
| Per 100 chickens | 4 | " " " |

These figures are about the average, but will vary according to the season, climatic conditions and other factors. Stock will drink more water in very hot weather and under high production.

In the home, the following are about average:—

| | | |
|---|---|---|
| Filling a hand wash-basin | 1½ | gal. |
| " a bath | 30 | " |
| Flushing the w.c. | 6 | " |
| Shower bath | 25 | " |

A ¾ in. hose with a nozzle will use between 275 and 300 gallons an hour, and a lawn sprinkler about 120.

Obviously, it is wise to select a pump which has a capacity in excess of the probable demand at any period. For instance, if the hose mentioned above were to be used during the mid-day cooking time, unless the pump had a capacity greater than 300 gallons per hour, there would be no water available for the household purposes, and complaints would very soon be heard, especially when the meal was not ready at the usual time!

It is wise to add 8 to 10 percent to the pump capacity in such a case, so that the capacity of the pump to be installed should be 320 to 330 gallons per hour, leaving a sufficient

margin for other uses even when the hose is being used.

Remember also that the capacity of the pump should be such that it will not have to run more than two or three hours a day at the most.

Tank size is a very important matter, whether the system adopted be gravity or hydro-pneumatic, and even may be considered to be more important than pump capacity for the average installation. In the case of the air-pressure tank in the hydro-pneumatic system, about one-third of the tank capacity is air, and only about a third of the tank's total water capacity can be drawn off before the pressure inside falls to such a point that the motor is started up. So it is clear that while a very small tank would provide sufficient pressure to work, it would be most extravagant to install it. A 9-gallon tank, for instance, would only provide less than 3 gallons of water before the motor started up; a motor takes most current when starting, so that any money saved by the insallation of a small tank would be swallowed up very quickly indeed in unnecessarily high electricity bills.

Water is the first thing we want in the morning, and the last thing before we retire. We need plenty of it at the kitchen sink, the toilet and the bath, for cleaning and scrubbing, for watering the lawn, and for poultry and livestock. Therefore, the sensible thing to do is to put in a system that will not only supply water when it is wanted, but plenty of it, and have something in reserve as well.—*Rural Electrification.*

## Mabel H. Adie, Presented

At the Civic Reception to Their Majesties, King George VI and Queen Elizabeth, at St. Catharines, on the afternoon of June 7th, the first person to be presented, following the civic officials, was Mabel H. Adie, book-keeper in the St. Catharines office of the Hydro-Electric Power Commission of Ontario. Her three silver crosses worn on a ribbon around her neck brought the comment from His Majesty: "I think I can see why you are here."

Miss Adie's family has the record of having made the greatest sacrifice of any in the St. Catharines area during the World War; three of her brothers having been killed overseas. Her parents being deceased it fell to Miss Adie's lot to represent this distinguished family on so memorable an occasion.

# THE BULLETIN

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# Mutual Interdependence

## Some Comments on Thirteenth Bills, New Legislation, The Water Heater Question, Sales Promotion, Load Conditions, The Ontario Municipal Electric Association and the Commission, Mutual Interdependence, and Northern Ontario

By Dr. T. H. Hogg, Chairman, The Hydro-Electric Power Commission of Ontario

IN the main the addresses which I have made at the various meetings of the Ontario Municipal Electric Association have taken the form of running commentaries on events of interest to this association as they have transpired. District meetings have afforded an opportunity for dealing with matters of local interest, while subjects of the broadest application and interest have been dealt with at the midwinter and summer conventions. It appears that a number of subjects which properly belong to the latter category were discussed by me at a meeting of District No. 8 held at Chatham a few weeks ago, for I have been informed by your President and Secretary that many of my remarks were of such general interest that they should be repeated here notwithstanding the fact that they were published in the May issue of *The Bulletin*. At their suggestion therefore I am including in my talk tonight some comments upon thirteenth bills, new legislation enacted at the last session of the legislature, the water heater question, and the subject of municipal interdependence.

Address presented to the Ontario Municipal Electric Association and the Association of Municipal Electrical Utilities at Ottawa, July 4, 1939.

### Thirteenth Bills

First let me refer to the question of interim rates and their corollary, commonly called the "13th Bill".

## CONTENTS

**Vol. XXVI** **No. 7**

**July, 1939**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission: to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interested are invited for publication.*

The term "13th Bill", used in the general sense to describe what in reality is an annual adjustment account, is more often than not a misnomer for it usually takes the form of a credit and not a debit as the name implies. I need not enlarge upon the fact that this annual adjustment account is the means by which your total annual payments are brought into agreement with the annual cost of your service as computed after the close of the fiscal year. It represents the difference between the sum of twelve monthly power accounts rendered on the basis of estimated interim rates, and the actual annual cost assessed to the municipalities which can be determined only after the annual adjustments have been made. This difference between annual revenue derived under estimated interim rates, and the actual annual power costs, is concentrated into a single "13th Bill" at the year end. If the difference is substantial and unexpected, and particularly if it should take the form of a debit, it is natural that the effect may be somewhat disturbing.

The point we are now discussing must not be confused with the question of a stable cost of power, however desirable the latter may be, for, as I have explained a number of times lately, it is the function of the rate stabilization fund to iron out marked variations in the cost of *system* power to whatever extent this is practicable.

We are now concerned with how to collect whatever revenue may be needed from each municipality as determined after all adjustments have been made, also with the evident desirability of choosing interim rates which will yield that revenue, as closely as possible, so as to spread the great bulk of the actual annual cost over twelve pro rata annual payments. When this is done the effect of the "13th Bill" is comparatively small. But practical difficulties in the way of estimating the cost of power a year in advance should not be overlooked. Variations affecting costs occur from year to year due to:

1. Increases or decreases in the cost of production and distribution, including generation, purchased power, transformation, transmission, etc., and,
2. Variable increases or even decreases in load; in other words, variations in the extent to which

available resources are fully and profitably used.

This effect of increases and decreases in the cost of available resources and facilities and of changes in load demand is felt upon a system-wide scale which affects every cost customer, and it is also felt on lesser scales in varying degrees down to only a small group or even a single customer. For example, changes in the lump sum cost of generation and purchase of power and changes in the total primary demand affect all customers, while changes in the cost of a transmission line or a distributing station, or changes in the load carried by a line or station may affect only one customer.

It is much easier to estimate one year in advance what the lump sum cost of power resources and transmission and distribution facilities will be, than it is to estimate the effect of changes in the system load or the load of any individual municipality upon the per horsepower cost; in other words, uncertainty as to what the loads will be constitutes the greatest element of inaccuracy in estimating the interim rates that will closely approximate actual costs.

On the Niagara system, during the last few years, variations in both these elements, that is in the lump sum cost of power and in the extent to which power resources were utilized to supply profitable loads, have been more than usually great. The agreements under which a final settlement of the Quebec power issue were made had an important bearing on cost. In order to effect this important settlement it was necessary for the Commission to accept definite obligations to take and pay for increasing quantities of Quebec power for a number of years. Fortunately the increases that remain to be taken during the next few years are not large. Added to this, the uncertainty of industrial conditions has undoubtedly had a dampening and perhaps somewhat erratic effect upon load growth.


*T. H. Hogg, B.A.Sc., C.E., D. Eng., Chairman and Chief Engineer.*

Now, returning to the question of interim rates, you will recall that on November 1, 1936, the interim rate to practically all municipalities in the Niagara system was reduced by an amount of $2.50 per horsepower per year; again on August 1, 1937, a further reduction of $2.00 per horsepower per year was made. Bearing in mind the increase in system power commitments and the fact that load increases have not been sufficient to fully utilize the additional quantities of power thus made available, it is not surprising that following these two virtually flat reductions in interim rates, the revenue from certain municipalities has not been sufficient to meet the actual cost of serving them. As a result, it was necessary to render thirteenth debits to 23 Niagara municipalities for the year ending October 31, 1938, while 152 municipalities received credits.

As some of these debits were comparatively large, it is only natural that the municipalities which received them should indicate a desire—as they have actually done—to be billed on a basis which more nearly approximates actual cost and eliminates so far as possible substantial thirteenth debits. As a first step in this direction the Commission has increased the monthly interim rates to seventeen municipalities.

Had graded reductions in interim rates been made instead of the two flat-rate cuts totalling $4.50 per horsepower, there would have been no occasion for any substantial thirteenth debits. Furthermore the question of substantial thirteenth credits would also have received attention and even these would largely have been averted except perhaps where capital projects pending in the near future might be likely to increase costs.

*It is important to bear in mind that interim rates and any changes therein have no effect whatever upon the total annual payments for power by any municipality.* Each municipality must pay its actual annual cost. The advantage of adjusting interim rates lies entirely in spreading the annual cost more evenly over twelve monthly bills and leaving a smaller and comparatively insignificant sum to be taken care of by the thirteenth account.

In this connection it is interesting to note that so far as any trend in future power costs to municipalities is concerned, it should be downward rather than upward, in consequence of a more complete utilization of available resources to supply primary power demands.

### New Legislation

In order to keep your Association informed about changes in the fundamental basis for the Commission's operations and the authority under which the Commission acts, I want to mention briefly the new legislation which was enacted at the request of the Commission at the last session of the Legislature. New bills were introduced and new legislation enacted in relation to the Guelph Railway, Rural Bonus, and the Power Commission Act.

Very broadly The Guelph Railway Act, 1939, authorizes the Commission to transfer to the City of Guelph the street railway in that city.

The Rural Hydro-Electric Distribution Act providing for 50 per cent bonus on certain rural lines was amended to clarify the meaning and meet the needs of present-day rural distribution. Formerly the bonus was limited to the capital cost of constructing primary transmission lines and cables, service transformers and meters and secondary lines on the highway. Henceforward, the cost of acquiring land may be included because in some locations we have to keep off the highway.

The Act has also been somewhat simplified and modified so as to bring it into closer harmony with rural requirements. The Commission is also enabled to extend the benefits of rural service to Northern Ontario as it has done elsewhere.

With regard to the rate stabilization fund, this Commission has acted upon your suggestion that power to transfer surplusses or credits of municipalities or rural power districts be eliminated. This has been accomplished by amendments to The Power Commission Act.

### Water Heaters

I imagine that most of you are now aware that the long-standing water-heater problem has been settled, but even so, a few words as to the basis of settlement may be in order.

The Commission has agreed to rebate 50 per cent of the installed cost of flat rate water heaters for installations made prior to October 31, 1936.

The Hydro flat rate water heater was first developed as a load builder in 1932; at that time it was intended that the cost of the heaters would be met by drawing upon reserves. Later it was decided that the cost of the heaters would be included in the cost of power and the municipalities were billed accordingly. The municipalities objected to this charge and eventually it was arranged that each municipality would thereafter pay for the cost of its own water heaters, but the question of paying for the original heaters, installed before October 31, 1936, was left in abeyance.

The settlement just made, under which the Commission rebates 50 per cent of the cost of the original 24,000 water heaters out of the contingency funds, at a total cost of about half a million dollars, was proposed by the Ontario Municipal Electric Association with the assent of those municipalities which installed the original heaters.

### Sales Promotion

Last February the Commission's Director of Sales Promotion, Mr. M. J. McHenry, gave your association a comprehensive outline of the Commission's plans for a continuous campaign to promote the sale of electrical energy. This work has now been under way for some months and I am very pleased with reports of the excellent co-operation received from the great majority of the municipalities. I think Mr. McHenry made it clear that his department will act as a sort of headquarters, formulate plans and point the way as to how certain results can effectively be accomplished. But he also made it clear that if we are to be successful, the municipalities, themselves, must contribute the main effort and must follow up the

work of the Commission's Sales Promotion specialists.

Already a great deal of good work has been done and while it is too early to expect this work to show tangible results which can be directly traced to it, I have not the slightest doubt but that beneficial effects are there and that they will be much more substantial and more noticeable as time goes on. As evidence of this, it can be shown conclusively that the sale of electrical appliances has been stimulated wherever a municipality has given its whole-hearted support to the plans put forward by the Commission's staff.

Unfortunately I believe that there are a few municipalities which, as yet, are unconvinced that benefits are to be derived from co-operating in this work. I would like to point out to them that the Commission's object in this campaign is not primarily to promote the sale of electrical appliances, even though such sales will no doubt react to the benefit of the municipalities and of the Province at large. The Commission's real object is to increase the use of electric energy so as to better serve our citizens and increase the revenues of every municipality.

And let there be no doubt about the advantages of this. The ultimate effect of increasing revenue is to reduce the cost of power and it is my firm conviction that reductions will be obtained through the promotional efforts of individual municipalities acting in conjunction with this Commission. I am convinced that the best interests of every municipality will be served by joining whole-heartedly in this work and that, after it has been given a fair trial, the benefits will become apparent.

### Load Conditions

The demand for primary power on the Commission's Eastern Ontario system held up remarkably well through the industrial recession which was prevalent last year, and, since the commencement of the current year, increases over the demands of a year ago have been gaining despite the rather unsettled industrial outlook. Compared with the long term trend on the Eastern Ontario system, which for the past fifteen years has shown an annual average increase of 5.6 per cent, the increase during the past five months, or since the beginning of the year, has averaged 5.9 per cent over the like period a year ago. Last month the increase was 9.1 per cent over May, 1938, and in June the increase is likely to be greater. Last winter the total primary load of the Eastern Ontario system was 132,000 horsepower which is just about double the peak demand which occurred in 1925, thirteen years ago.

In addition to all this, Eastern Ontario will shortly benefit through the construction of a new factory at Kingston. The Aluminum Company of Canada has signed a contract with the Commission for 7,000 horsepower for use in that factory. Altogether the outlook for Eastern Ontario, in which district we are now holding our meeting, is bright.

This healthy load growth is not confined to the Eastern Ontario system alone. Other undertakings of the Commission as represented by the

Georgian Bay system, the Thunder Bay system and the large Niagara system are all showing satisfactory increases over loads of a year ago. During the month of May, for which latest records are available, the primary load on the Niagara system increased 4.6 per cent over May, 1938; the Georgian Bay system, 11.8 per cent and the Thunder Bay system 7.9 per cent. The primary load of all systems combined, which includes the Northern Ontario Properties where substantial load growth due to progress in mining developments continues, shows an increase in May of 7.3 per cent.

### TAXATION INCREASES POWER COSTS

There is a matter of considerable importance which has been brought to the fore from time to time and recently has been raised again. It is a question which may become of considerable importance to your association and it is one that should be thoroughly understood. I refer to the taxation of Hydro properties.

I do not propose, to-day, to discuss this matter at any length but I do want to comment briefly on one phase of the broad question, that of its effect upon the cost of power. Do not be misled by any statements or arguments purporting to show that additional taxation of the properties of The Hydro-Electric Power Commission of Ontario, or of the municipal utilities, will have no effect upon the cost of power to the consumer. The users of electrical energy pay the cost of their service; neglecting the rural bonus, there is nobody else to pay it or pay any portion of it, and if additional municipal taxes are levied on Hydro properties, over and above the four hundred thousand dollars now paid by the Provincial Commission alone, thereby increasing the wholesale cost of power, as well as the cost of municipal operations, *the consumer will surely pay those extra charges.*

### THE O.M.E.A. AND THE COMMISSION

Now I want to say a few words about your Association: In order to fulfil its proper function, the Ontario Municipal Electric Association must receive from The Hydro-Electric Power Commission of Ontario a good deal of information concerning the policies, the projects under consideration, and the operations of the Commission. It is our wish as well as our duty to assist your organization to play an important part in Hydro affairs and it is mainly for this reason that my remarks at your conventions are very largely confined to business.

No enterprise can flourish without firm and courageous leadership. In the Commission's case, the municipalities rightly feel that they are entitled to a voice in the affairs of the Commission. I have said over and over again that I agree with this, but I want to enlarge upon the point a little and draw some distinctions between the responsibilities of the Commission and of the municipalities as exercised through your association.

In the past, various charges of arbitrary and autocratic action have been levelled against this Commission. Unless the Commission degenerates into a body which virtually does nothing, I am afraid the opportunity for such charges, whether or not they be warranted, cannot altogether be elim-

inated; for the final responsibility for decisions on important questions of wide interest and of a highly controversial nature must be accepted by The Hydro-Electric Power Commission of Ontario. This Commission is a legally constituted responsible trustee; this being so, it is this Commission and not the municipalities either individually or collectively, which is responsible for the administration of the business which is of such vital importance to each municipality and to all municipalities, and, while the Commission should consult the municipalities, there is no way by which it can hand back to them the responsibility for making important decisions.

You all of course know quite well that it would be impossible for the Ontario Municipal Electric Association to direct the affairs of the Commission, but you also know how very, very important it is that your association and the municipal electric utilities should be in accord with Hydro policies. The whole-hearted support of each of the individual municipal partners is essential to the complete success of the enterprise.

The question sometimes arises as to how this support can best be maintained, but of course the answer is obvious; the Commission must earn municipal support by the manner in which it does its work. It must consult the municipalities, give all a hearing and a friendly hearing, and through its decisions show that the whole-hearted support which it needs, is merited It follows, too, that the municipalities should give the Commission's views and suggestions friendly and careful consideration.

In the very nature of things the Commission cannot undertake invariably to carry out the wishes of the Ontario Municipal Electric Association, any more than the Association can blindly endorse any and all proposals of the Commission. But this I will say, that great weight should be attached to the views of the municipal utilities as expressed through their association and that so far as may be consistent with the broad interests of this great enterprise, they should be implemented by appropriate action.

### Mutual Interdependence

May I call your attention to the closeness of the association between your own municipal utilities. I refer to a relationship which will be apparent to any close student of Hydro affairs.

In the evolution of this co-operative undertaking, as in anything else, growth has been the dominant note, and where there is growth there is change. In our case there have been many changes of far-reaching consequence. Hydro municipalities have required more and more power; to meet their demands it has been necessary for the Commission to invest more and more capital and to undertake other long-term commitments on behalf of each group of municipalities, and on behalf of each municipality, pro rata, according to its need. While the original principle of community of interest remains in essence unaltered, this progressive enlargement under which each municipality assumes additional obligations from time to time, according to its own needs, alters and extends the responsibility of each

municipality. This precludes the possibility of interpreting the mutual obligations between the municipalities and the Commission in any narrow sense as to quantity or time, or of restricting their force and effect to the very limited scope of the Hydro enterprise envisaged by its founders.

For example, the contract with the original Niagara municipalities was based upon purchase contracts under which the Commission secured 100,000 horsepower from the Ontario Power Company, and the assumption that only such capital investments as might be necessary to distribute that power, would be made. This quantity of power was very soon exhausted; therefore it became absolutely necessary for the Commission to secure very substantial additional quantities of power as time went on, partly through generation and partly through purchase. These additional quantities of power have now become so large as to dwarf the commitments which were the basis of the original enterprise and the original contract.

It soon became apparent that the contractual foundation of the co-operative undertaking, which was quite adequate for its limited initial scope, was not sufficient to provide adequate safeguards as successive substantial enlargements took place. In order properly to take care of the individual and collective interests of the municipalities, it became necessary to alter and extend their obligations. This was done by legislative enactments which provided that each municipality should assume its proportionate share not only of the original capital outlays but of all additional capital outlays and all additional long-term commitments of any nature; at the same time the term of repayment of capital outlays was extended from thirty years to forty years. Thus, in effect, the acts provided that each municipality would become responsible for its share of the cost of all financial commitments for at least forty years after any such commitments were made.

I thought it might be of interest to you to reflect on this continuing feature of our co-operative enterprise which is essential to its extensive growth and which arises out of the necessity for successive expenditures on behalf of each system and each municipality. It is also well to remember the interdependence of the individual municipalities comprising each system and to bear in mind the nature and closeness of the co-operation and mutual responsibility inseparably linking each municipality with all the others, with the rest of the system of which it is a part, and with the Commission which administers the system. Unfortunately on account of illness Hon. Wm. L. Houck and Mr. J. Albert Smith cannot be with us tonight, although they very much wished to be here.

May I express my appreciation and the appreciation of my colleagues, of the relationship which exists between the various branches of your association and The Hydro-Electric Power Commission of Ontario. I can sincerely say to you that our dealings with your various representatives and with the members of your Association have been most agreeable and have been a distinct source of pleasure and satisfaction to me. I hope as we go

along our way that we will be conscious of an even closer community of interest. It is through a recognition of that community of interest and the spirit of mutual helpfulness that we shall be able to make the most of our very great opportunities to serve the best interests of the power users of this Province.

### Northern Ontario

Now, as some of you may know, I have just returned from a trip into the north country. I am so greatly impressed with achievements there, with the vast possibilities for the future and particularly with the basis or foundation for these achievements, past and future, that I could have devoted the greater part of my time today to the north country and its relationship to Southern Ontario. But although my time is almost gone I would like to speak of it for a very few minutes.

The transformation of the north country is startling, tremendously impressive, and thrilling. In the territory tributary to Sioux Lookout and Hudson, which only a few years ago supported about five hundred people, there are now over a thousand men at work in the mines and in a matter of two or perhaps three years there will probably be five times that many people, including dependents as well as workers.

This extraordinary expansion would have been impossible without hydro-electric power. Dependence upon steam and Diesel engines hampers and virtually throttles the operation of mines. The record of casualties among the mines dependent upon energy developed from fuel gives ample support to this statement.

But the natural advantages of hydro-electric power are not in themselves sufficient. There is something else that makes possible hydro-electric development on the present scale and at the present low cost which is so attractive and so important to the mines. Behind it all is the wisdom of the governments of the Province of Ontario and the Dominion of Canada, which, through the policy of aiding this territory, have done much to relieve unemployment and to develop a provincial and national asset of immense value. I say this of course without political implications of any kind whatever.

The Hydro-Electric Power Commission is the instrument through which a large part of the assistance is given. In this case the Commission acts as the trustee for the Government of Ontario. As you know, there is no possibility for a co-operative municipal enterprise in a country where virtually no municipalities exist, therefore direct government ownership is the only basis on which a publicly-owned enterprise can function.

On behalf of the Government, then, and not on behalf of any municipalities, The Hydro-Electric Power Commission administers the north country hydro-electric developments and, in co-operation with the Government, studies the mining prospects and exercises its best judgment as to what regions to enter and how best to serve them.

The Federal Government has assisted greatly through grants for projects such as roads, the cost of which is

divided between the Dominion and the Province, and has this year extended its grants to include a portion of the labor costs on the construction of transmission lines where these may later be used as roads over the cleared areas. With the Province underwriting the entire enterprise and the Dominion contributing part of the labor costs of transmission lines, the risk of individual projects is spread in such a way as to make otherwise impossible undertakings perfectly feasible and practical and to transform a country, which until quite recently has been lying dormant, into a source of immense wealth. Many thousands of people have been taken off relief and many more will be employed during the next few years.

Although the Ontario Municipal Electric Association is not directly concerned with the Northern Ontario branch of the Commission's activities, I thought its members would be interested from the broad point of view of good citizens, for, aside from the direct results of this growth and expansion, there are indirect effects which benefit Southern Ontario and, in fact, all of Canada. The purchase of equipment and supplies for the operation of the mines and of food and clothing for the employees and their families, furnishes a great stimulus to business and gives gainful employment to thousands of people who otherwise would suffer the demoralizing effects of unemployment, and in a thousand lesser ways contributes to the well-being of the people of Ontario.

In closing, let me express to you the appreciation of the Commission in being given this opportunity to meet you all again, to discuss our mutual problems, and to renew our friendly contacts. It is always a pleasure to me to attend these meetings, in this case *somewhat* mitigated by the fact that I have to make this speech. I thank you for your attention. Again let me thank your executive for the privilege of being with you.

# Sale of Unapproved Water Heaters

DURING the many years that the Commission has been administering the regulations governing the sale of electric equipment, it has encountered at times cases of deliberate and unscrupulous attempts to circumvent these efforts. As early as 1931 several particularly glaring examples of such attempts occurred which were followed by more in 1932. These referred particularly to unapproved and substandard types of electric water heaters containing particularly dangerous features and which were offered for sale throughout Ontario. At that time *The Bulletin* attempted to give publicity to the tactics followed in order to fully warn the public and no effort was spared by the

Electrical Inspection Department in laying charges against distributors which resulted in prosecutions and convictions. Following this the activity in the sale of these appliances practically ceased.

Recently, however, the traffic has come to life again with tactics even more unscrupulous. The companies making the heaters take no responsibility for them after the shipments have been made. They are all made in the United States and are sold by mail order to individuals or to agents who are encouraged to peddle them from house to house. The order form of one particular company is printed to provide for payments in cash with the order or if desired a deposit with the order and the goods shipped C.O.D. Attached to the form, however, is a typewritten note: "We can make no C.O.D. shipments into Canada. Full remittance must accompany each order." The reason for this is the fact that the Commission has advised a number of distributors to return the heaters and threatened them with prosecution if they disposed of them. The manufacturer does not relish the idea of returning the money.

In all of these heaters the electric element is in contact with the water and usually consists of a coil of bare heating element mounted on a piece of asbestos board, enclosed in a perforated sheet metal case. This type is supplied with a length of rubber-insulated cord and is designed to be immersed in the water which it is desired to heat. An attempt is made to deceive the unsuspecting public by the statement shown on the reproduction of a pamphlet of this heater, viz.: "Underwriters' Laboratories Seal of Approval is on the 8-foot cord of every Lux Electric Water Heater". The Electrical Inspection Department called this matter to the attention of the Underwriters' Laboratories Incorporated, who then took the matter up with the Federal Trade Commission at Washington and we understand the advertisement has been modified somewhat. Again on the reverse side of the same advertisement is the reproduction of the First Class Seal of Approval of The American Public Service Testing System. The same company circulates reproductions of a Certificate of Merit issued with the seal of approval. The American Public Service Testing System and a number of other similar organizations are not recognized in Canada or elsewhere as far as the Commission can find out, and any certificate or seal emanating from any of them as to electrical equipment is of no value in this country. There are only three recognized testing laboratories for electrical equipment on this continent; The Underwriters' Laboratories Incorporated in Chicago; The National Research Council Laboratories in Ottawa, and The Hydro-Electric Power Commission of Ontario Laboratory in Toronto. Regardless of such misleading certificate and seal of approval the Commission's Laboratory has found the heater to be *unsafe* and has *condemned* it for sale in Ontario. Another type is designed for attachment to a faucet, but is essentially the same as the immersion types and contains the same hazards and has also been condemned.


*Reproduction of an advertisement of a dangerous appliance.*

If the user should touch the water or any metal vessel containing the water in which the heater is immersed, he would be subject to danger from electric shock. Tests have been made in the Laboratory indicating that voltages of from 50 to 110 exist between the water near the heater and the neighbouring grounded objects such as a faucet: these conditions being just right to cause a fatal accident.

These water heaters consume a considerable current, between 15 and 25 amperes. It is usually necessary to remove the 15 ampere fuses protecting branch lighting circuits and replacing them with fuses of a larger

THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO

## ELECTRICAL INSPECTION DEPARTMENT

# WARNING

### DANGEROUS ELECTRIC WATER HEATERS

It has come to our attention that unapproved and sub-standard types of **ELECTRIC WATER HEATERS** containing particularly dangerous features are being offered for sale in Ontario, contrary to the law.

**THESE UNAPPROVED HEATERS ARE OF TWO TYPES**

1. Faucet Type, with portable cord, manufactured under the following names:
   *"Tom Thumb Senior and Junior," "Hot Shot," "Aladdin," "Major," "Vulco," "Utility," "Kwik," "Kwick" and many others.*

2. Immersion Type, with portable cord, manufactured under the following names:
   *"Lux," "Lux-Visel," "Magic Disc," "Mystosol," "Aladdin," "Wonder," "Jiffy," "Bestever," "Comer," "Hot Donut," "Nu-Way," "Speed-King," "Real Products," "Kwik," "Kwick," or "Benson Specialty Company," and many others.*

**It is unlawful to advertise, sell or otherwise dispose of any Electrical Equipment other than that which has been approved by the Commission.**

**It is unlawful to use any Electrical Equipment unless and until it has been approved by the Commission.**

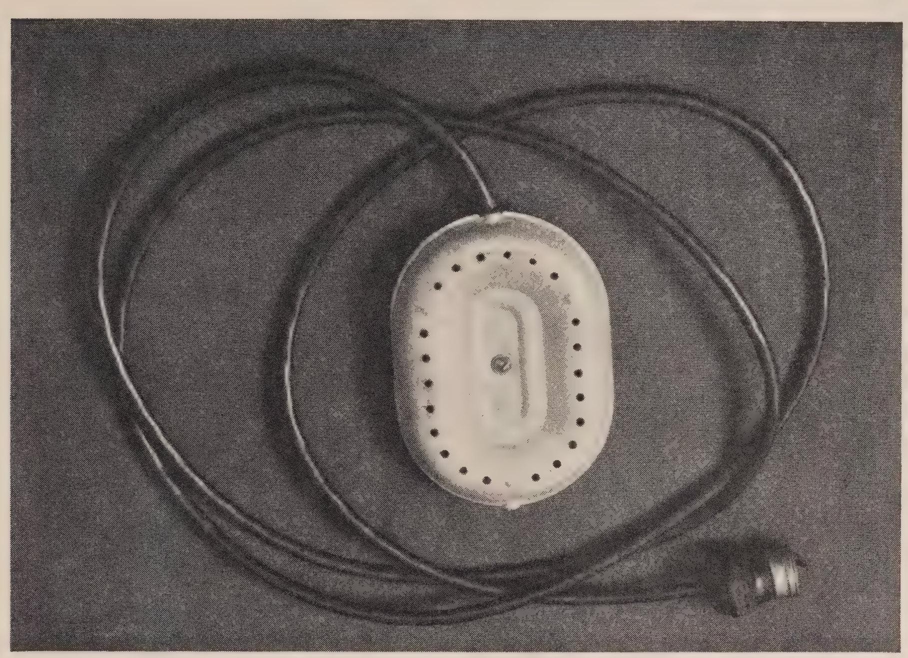
*See Rules and Regulations Respecting Electrical Equipment.*

For refusing or neglecting to comply with the provisions of the Rules and Regulations of The Hydro-Electric Power Commission of Ontario, made pursuant to The Power Commission Act the offenders are liable to prosecution.

**BEFORE PURCHASING ELECTRICAL EQUIPMENT DEMAND PROOF THAT IT HAS BEEN APPROVED BY THE COMMISSION**

A. G. HALL, *Chief Electrical Inspector*

*Reproduction of warning notice issued by the Commission.*



*Assembly of a typical unapproved water heater.*

ampere rating, in order that the heater may operate satisfactorily. This, of course, conflicts with The Canadian Electrical Code wiring regulations, which call for fuses of not greater than 15 amperes rating to protect the branch lighting circuits. If larger fuses are used the wiring is not adequately protected, and a fire hazard may be caused due to overheating of the wire. The supply cord used on these heaters is greatly under-rated, having a capacity of 3 amperes, whereas the power consumption is 5 to 8 times the capacity of the wire in the cord. Should a heater be connected to the supply and not be in water, its life would be short and the danger of fire great.

The Inspection Department extends no sympathy to anyone caught selling substandard water heaters or other dangerous electrical equipment. It is ever vigilant in its endeavour to protect the users of electricity and will not accept ignorance of the law as an excuse. During the summer of 1938 there were several convictions in the Belleville and Kitchener districts and the latest was one at Timmins on the eleventh of this month where an agent caught selling substandard water heaters was fined $10.00 and costs and had to cancel orders, thus having to make refunds where collections had been made in advance of delivery of goods.

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*Note*—We suggest that the local newspapers can assist us in conveying the warning contained in the above to the attention of the general public by reprinting it.—EDITOR.

# Public Utilities Under The Ontario Workmen's Compensation Act

By T. Norman Dean, M.A., F.S.S., Statistician, The Workmen's Compensation Board, Ontario

ANY discussion of "Public Utilities under the Ontario Workmen's Compensation Act" requires a very careful definition of the term "public utility." In this paper the term is used to describe the activity of a municipal or other governmental body functioning as a corporate body, that is a legal entity, to supply service of a specific character which service if not supplied by such municipal or governmental body would be supplied by a private employer. The Workmen's Compensation Act of Ontario provides specifically that private corporations of a public utility nature are under Part 1 of the Act, whether under Schedule 1, wherein the liability for compensation payments is collective upon employers, or under Schedule 2, wherein that liability is individually upon the particular employer. By Part 1 of the Act, employers are subject to the jurisdiction of the Workmen's Compensation Board, the authority created by the Workmen's Compensation Act to determine all matters in connection with the payment of compensation: by Part 2 of the Act employers, with the exception of those engaged in the industry of farming and domestic and menial servants and their employers, who are not included in Part 1, are not subject to the jurisdiction of the Workmen's Compensation Board.

Municipalities and municipal commissions as well as other governmental bodies are in somewhat different position than other employers, as different categories of work are under different parts of the Act. Subsection (2) of Section 1 of the Workmen's Compensation Act is as follows:

"The exercise and performance of the powers and duties of,—

(a) A municipal corporation;

(b) A public utilities commission;

(c) Any other commission having the management and conduct of any work or service owned by or operated for a municipal corporation;

(d) The board of trustees of a police village; and

(e) A school board

shall for the purposes of Part 1 be deemed the trade or business of the corporation, commission, board of trustees or school board, but the obligation to pay compensation under Part 1 shall apply only to such part of the trade or business as, if it were carried on by a company or an individual, would be an industry for the time being included in Schedule 1 or Schedule 2, and to workmen employed in or in connection therewith."

A paper read before the Ontario Municipal Electric Association and the Association of Municipal Electrical Utilities at Ottawa, July 5, 1939.

The language of this section is quite clear. All public utilities commissions are under Part 1 of the Act for such part of their work, which, if carried on by a private company or individual would be under Schedule 1 or Schedule 2 of the Act. The section governing Schedule 1 is as follows; Section 83:

"If any trade or business connected with the industries of lumbering, mining, quarrying, fishing, manufacturing, building construction, engineering, transportation, operation of electric power lines, waterworks and other public utilities, navigation, operation of boats, ships, tugs and dredges, operation of grain elevators and warehouses, teaming, scavenging and street cleaning, painting and decorating and renovating, dyeing and cleaning, or any occupation incidental thereto or immediately connected therewith, not included in Schedule 2, is not included in any of the classes mentioned in Schedule 1, the Board shall assign it to an appropriate class or classes embracing the trades or businesses not so included, and until that is done except in so far as it may be otherwise provided by the regulations such trade and businesses shall together constitute a separate group or class and shall be deemed to be included in Schedule 1."

By this section the "operation of electric power lines, waterworks and other public utilities" are covered under Schedule 1 if not mentioned in Schedule 2. Article 1 of Schedule 2 is as follows:

"The trade or business, as defined by Subsection 2 of Section 1, of a municipal corporation, a public utilities commission, any other commission having the management and conduct of any work or service owned by or operated for a municipal corporation, a board of trustees of a police village and a school board."

Hence public utilities commissions or municipal corporations operating public utilities services are under Schedule 2 of Part 1 of the Act, and are individually liable to pay the compensation awarded by the Workmen's Compensation Board and are also liable under Section 117 to

"Pay to the Board such proportion of the expenses of the Board in the administration of Part 1 as the Board may deem just and determine, and the sum payable by them shall be apportioned between such employers and assessed and levied in like manner as in the case of assessments for contributions to the accident fund and the provisions of this Part as to making such assessments shall apply *mutatis mutandis* to assessments made under the authority of this section."

By Section 88, Subsection 1:

"The Board may, upon the application of an employer add to Schedule 1, for such time and upon such terms and conditions as the Board may determine, any industry or part of an industry, or department of work or service of such employer."

The employer is given the right to apply for and the Board to accept or reject the application for coverage under Schedule 1, wherein the employ-

ers are relieved from the liability individually placed upon them to pay compensation, but are required to contribute to the Accident Fund.

It is perhaps beyond the confines of the present paper to discuss the relative advantages of Schedule 1 and Schedule 2, but it might be mentioned in passing, that under Schedule 1 the charge is fixed, that is, the rate is pre-determined within the limits of adjustment, while in Schedule 2 the charge is indeterminate.

Under Schedule 2, in order to protect themselves from accident costs which might be so grave as to produce financial embarrassment, if not annihilation, many public utilities commissions have had recourse to insurance with private insurance companies, a great many under the delusion that rates are less under such contracts than under the Workmen's Compensation Board's Accident Fund. This Accident Fund is a non-profit fund; it pays no taxes and in its general field it has no competitors, which means no agents' commissions are paid and there is only one set of officials in the Province to pay salaries to. In a word, private insurance companies' rates can never, with financial stability, be as low as the rates of the Workmen's Compensation Board.

This also must be noted, that in Schedule 2 the Workmen's Compensation Board, by the law, is the authority which determines all questions in respect to Compensation, and the Board looks to the individual employer for payment of claims and a prorated share of expenses of administration of the Act. If for any reason the insurance company refuses to pay the awards in whole, or part, as made by the Board, the Board cannot, and hence does not, decide the right or merit of such refusal, but looks to the employer and holds such employer individually and immediately liable for the whole award.

In the State of Massachusetts all compensation insurance is handled the same as Schedule 2 of the Ontario Workmen's Compensation Act. That is, the liability is put upon the employer and he is allowed to take out insurance with a private insurance company. The following figures which have been derived from official sources might be of some interest in this connection.

Year 1935

| | Massachusetts | Ontario |
|---|---|---|
| Compensation coverage | 98.3% | 100% |
| Number of insurance companies | 33 | 1 |
| Percentage disbursed of net premium | 74.56 | 91.1 |
| Percentage disbursed of net premium for: | | |
| (a) Compensation | 25.43 | 63.2 |
| (b) Medical Aid | 12.66 | 19.5 |
| (c) Safety | 1.31 | 2.8 |
| (d) Acquisition costs | 6.53 | 0 |
| (e) Other administrative costs | 9.76 | 5.6 |

At the end of 1938 there were 224 municipal electric commissions, or municipalities conducting electrical services who had applied to the Board and whose applications had been accepted for coverage under Schedule 1. There were also 253 municipalities, counties or commissions under application for services other than electrical under by application. The rate charged for electrical operations for the year 1938 was $1.50 and the provisional rate for 1939 (subject to adjustment) at the end of the year was $1.50 also. This means for each $100.00 of pay-roll covered, full compensation coverage, without limit and covering all employees, the Workmen's Compensation Board charges $1.50, the benefits to those injured and to the dependants of those killed being those set out in the Workmen's Compensation Act. The benefits are as great as those given by any other jurisdiction in the world and the rates are very low when compared with those of other jurisdictions.

In this connection it has been suggested that some discussion should be had of the unfortunate *contre-temps* which was occasioned by the Board withdrawing coverage at the end of 1936 and by reason of which many public utilities sought insurance elsewhere. The whole matter was a mistake, instigated perhaps through a certain panic the result of claims from municipal relief workers and the rescision of the order withdrawing coverage followed. The assurance that it was a mistake should preclude the possibility of a repetition. The damage done would have been greatly lessened if those interested had been circularized when the mistake was corrected.

Each public utility which comes under Schedule 1 of the Act becomes a member of the Electrical Employers Safety Association, an association for accident prevention subsidized by the Workmen's Compensation Board. The association is directly under the charge of Mr. Wills Maclachlan and provides technical, engineering and educational assistance and information calculated to aid and assist the employer in keeping down the frequency and severity of accidents to his workmen. A close check is kept by the Board on an employer's accident record and if it appears that there is an excessive number, that fact is promptly called to the attention of the employer. Complete co-operation exists between safety association and the Board and co-operation between employers and safety association is equally desirable. It is infinitely better to prevent an accident than it is to compensate it. There is no doubt at all that accidents can and should be prevented: it remains for the employer to take advantage of the services provided to assist in minimizing and mitigating the frequency and severity of accidents.

# Modern Developments in Distribution Transformers

By W. L. Miller, B.A.Sc., Transformer Engineer,
Canadian Westinghouse Company Limited

TODAY the electric light and power industry is very much interested in reducing operating expenses. Considering the four main divisions in the production and application of electric energy, generation, transmission, distribution and metering it would appear that the greatest opportunity for cost reduction is connected with distribution.

While past experience has shown that distribution transformers are very reliable yet every year many service interruptions occur chiefly as a result of lightning disturbances. These outages occur in spite of lightning protection and result in maintenance expense. With the increasing domestic load of refrigerators, ranges, etc., the question of service continuity has become one of paramount importance, both from the viewpoint of loss of revenue and customer good will.

In the past the conventional distribution transformer has had associated with it separately mounted fuse cutouts and lightning arresters. It was felt for many years that if these protective devices could be combined with the transformer into a unit construction that substantial savings would result due to greater ease in handling and lower installation costs. In the development of this unit construction extensive research in the past few years aided by an increased knowledge of lightning surges and their behaviour has made possible not only notable savings in cost but still more important improvements, culminating in the production of a completely self-protected transformer. The designer's dream of producing a distribution transformer capable of withstanding a direct stroke of lightning without service interruption has become a reality. This fact is being substantiated both from field experience and by commercial impulse testing. The improvements in construction that now make this possible will be described in more detail.

### THREE POINT PROTECTION

In every distribution transformer there are three major insulation points that must be protected.

1. Between high voltage winding and the core or tank.
2. Between low voltage winding and the core or tank.
3. Between high and low voltage windings.

Adequate protection against a lightning stroke requires that the lightning protective devices limit the surge voltage that can appear across these insulations. In addition there are

A paper read to the Association of Municipal Electrical Utilities at its Convention at Ottawa on July 4 and 5, 1939.

three minor insulations: turn to turn, layer to layer, and coil section to coil section. By the internal design of the coils it is practical to limit the surge voltages that can appear between turns, layers and coil sections to safe values.

Three point protection is a term applying to protective devices and their arrangement which limit the voltage appearing across each insulation to safe values. In order to be universal in its application it must provide this protection independent of the ground resistance and protect against surges on both primary and secondary lines.

This type of protection can be secured by the connection of suitable lightning protectors between the primary leads and the tank having discharge characteristics less than the insulation strength between primary winding and tank or core. The maximum surge voltage appearing across the insulation between the low voltage winding and core can be safely limited to a value less than its breakdown strength by means of the flashover value of co-ordinated low voltage bushings. With the voltage limited between the high voltage winding and core, and between the low voltage winding and core, it follows that the maximum voltage between windings is also limited.

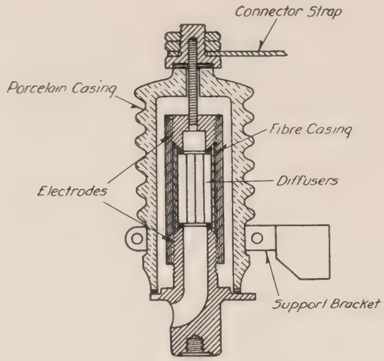
The common conventional method of protecting distribution transformers has been to connect lightning arresters between the distribution lines and ground. This method has proved inadequate as it does not provide complete immunity to outages. The transformer is exposed not only to the lightning discharge voltage of the arrester but to this voltage, in addition to which is added the voltage drop in the ground lead and in the ground itself. In cases of uncertain grounding conditions at the transformer, service conditions can be improved by interconnecting the lightning arrester and the secondary neutral especially in urban districts where the neutral secondary is exceptionally well grounded to water pipes at customer's premises.

In the earlier study of the improvement of distribution transformer performance the possibility of using protective gaps and co-ordinated bushings only was considered. While this is the simplest form of surge protection it was abandoned as it did not solve the problem of fuse outage resulting from gap operation or bushing flashover.

One of the latest forms of lightning protectors developed uses the principle of the de-ion tube. By connecting these de-ion gap arresters between the primary lines and tank, together with the use of co-ordinated low voltage bushings, the principle of three point protection has been achieved and positive protection provided for all three major insulations.

### De-ion Gap Arrester

As shown in the illustration the de-ion gap consists of two electrodes encased in an insulating tube, one being totally enclosed and the other open for venting to the atmosphere. Between these two electrodes is placed a diffuser consisting of slotted white fiber plates which serves to prevent and occasionally to interrupt any power follow current. In addition to the de-ion gap proper, a series resistor is used.




CROSS SECTION VIEW OF 4600 VOLT DE-ION GAP

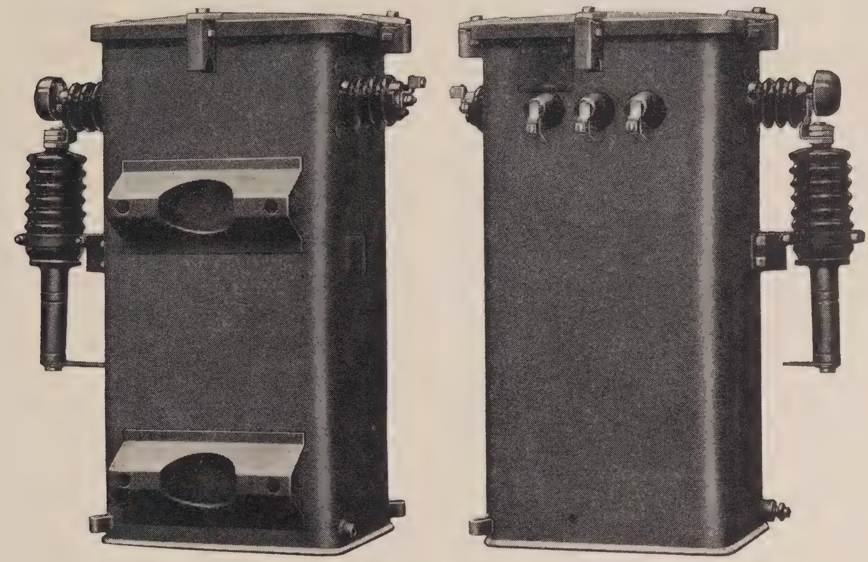
In operation when a severe surge is applied to the transformer, the voltage rises to a value sufficient to jump over the gap between electrodes, and the surge passes through the slots in the diffuser discharging to the tank and thence to ground. In case the surge occurs at a time when the line voltage is sufficiently high to maintain an arc against the de-ionizing action of the gaps, a flow of power current will follow. The magnitude of this power current is limited by means of the series resistor. The heat from the discharge passing through the slots in the diffuser causes gas to be driven off from the fiber slot walls. This gas mixes into the ionized path of the electrical discharge in such a way that at the first current zero the dynamic current is quenched and normal line voltage restored.

The discharge voltage of the de-ion gap is fixed by design at approximately one-half the surge strength of the high voltage winding. The flashover value of the co-ordinated low voltage bushings is made about one-half the surge strength of the low voltage winding. In case of a very severe stroke of lightning the impedence of the ground at the transformer may be sufficient to raise the potential of the tank to such a point that flashover takes place to the low voltage bushings and part of the surge current is discharged through the service ground connection. The low voltage bushings are provided with a selective neutral gap so that flashover always takes place to the grounded neutral instead of to the phase leads. This prevents the surge current from damaging connected apparatus.

### Advantages of De-ion Gaps

These gaps operate only when a surge occurs of sufficient magnitude to endanger the transformer. While the breakdown voltage of a gap arrester is about three times that of the ordinary lightning arrester for 2,300 volt systems, there are a number of reasons why a high flashover level is desirable. Surges due to system overvoltages, transients and surges of low magnitude which can do no damage will not cause gap operations. The high flashover values result in large natural clearances with small possibility of leakage currents and radio interference.

The study of transformer service records has shown that surge currents of relatively high magnitude are impressed on distribution transformers much more often than was suspected. In unshielded rural areas in some cases surge currents of 50,000 amperes or more may be expected. Experimental tests on the latest design of de-ion gaps indicate they can successfully discharge currents as high as 120,000 amperes. Surge currents in excess of 100,000 amperes are



*Distribution transformer with de-ion gap for 4,600-volt line (one line grounded).*

seldom experienced in service and would normally be discharged from the high voltage lines through both gaps in parallel. It therefore seems reasonable that the de-ion gaps as manufactured at present are capable of discharging the surge current associated with direct strokes of lightning on distribution lines.

The design of the de-ion gap is admirably suited for discharging these high surge currents. It is fundamentally an energy by-passing device and under conditions of very high current surges it is not necessary for the de-ion gap to absorb the energy in the surge. This is an important considertion in the case of multiple lightning strokes. Due to the arc characteristics of the de-ion tubes, the voltage across the gap during the discharge of high surge current is negligible. The almost instantaneous drop in voltage stress across the transformer insulation as soon as the gap flashes over, prevents damage to insulation even under a direct stroke of lightning at the transformer location.

In the latest design the resistor has been mounted as a separate unit outside the case while the de-ion gap as it is not affected by transformer oil may be mounted internally or externally. The series resistor is provided with a shunt protective gap which flashes over on large surge currents such as those over 10,000 amperes. While this eliminates the series resistor from the power follow circuit it has been found that power follow currents do not occur after these high current surges.

The de-ion gap is purely a mechanical device and does not have to be hermetically sealed to prevent the entrance of moisture. Moisture does

not affect the operation of the gap. With each discharge a small erosion of the walls of the fiber slots takes place depending on the magnitude of the power follow current which is limited by the series resistor. Even on a rural line application where the greatest number of gap operations would occur the de-ion gap will handle thousands of discharges without impairing its effectiveness. There is no progressive deterioration of de-ion gaps due to the voltage being continuously applied. The comparatively high flashover value allows the combination of de-ion gap and transformer to be given the standard A.I.E.E. test as a unit insuring that not only the windings but also the gap has a high insulation level.

### Fuse Outages

It is now known that heavy surge currents only will blow primary fuses. Considerable valuable data regarding fuse blowing caused by lightning have been accumulated and published in the transactions of the American Institute of Electrical Engineers of April, 1938. These data have been collected from 41 different operating companies representing urban, suburban and rural territories. For all types of territories it was found that fuse outages per 100 transformers varied from 1.85 to 10.1 being much higher in rural districts. Connecting the lightning arrester ahead of the fuse apparently reduces the number of outages. One definite conclusion that can be drawn from these data is that fuse blowing from lightning cannot be entirely eliminated without in some way eliminating the fuse itself. This is just what has been done in the completely self-protected transformer, as described later.

### Overload Capacity

It has been recognized that distribution transformers have considerable latent short-time overload capacity. In service the conditions established for the rating of a transformer seldom exist concurrently or continuously nor the maximum capacity used for any great length of time. Under many conditions transformers have a latent capacity over and above either ratings particularly for short time periods. This latent capacity depends upon the temperature to which the insulation can be safely exposed and the length of time it is exposed. As copper temperatures rise and fall with the ambient temperature it follows that the latent capacity is greatest when the ambient temperature is low.

The utilization of this latent overload capacity is desirable for two reasons:

1. Short time overload capacity may be needed in emergencies due to the failure of some part of the distribution system.
2. Short time overload capacity can be used to carry peak loads and thus reduce the average size of transformer for a given load.

Users of transformers are interested in making use of this latent overload capacity in order to reduce costs and improve quality of service, provided it can be done safely and economically. This necessitates a practical method of operating transformers up to but not beyond the safe limits of temperature for different loads and time periods.

Obviously the primary fuse is inadequate for this purpose as its thermal characteristics are entirely different from those of a distribution transformer. The latter will carry heavy overloads for short periods of time, less heavy overloads for a longer period of time, etc., without exceeding a given temperature. The fuse link blows in a short time at any value of current in excess of its rating. If the fuse link is chosen small enough to protect the transformer against overload, the short time overload capacity of the transformer is sacrificed and excessive fuse outages will result. If the fuse link is large it will protect the transformer against short circuit and also allow utilization of the transformer overload capacity, and while fewer fuse outages will occur no protection is afforded the windings against burnouts due to overloads. Usually the fusing is a compromise between the two extremes.

However, there has been developed an economical means of safely utilizing the overload capacity of transformers. In distribution transformers this takes the form of a small circuit breaker in the secondary winding.

### THE SECONDARY CIRCUIT BREAKER

This circuit breaker uses the same mechanism as the Nofuz breakers in common use in buildings replacing plug fuses. It is mounted inside the transformer tank beneath the oil level and operated externally by means of a bell-crank handle through a packing gland. The mechanism is trip free of the handle, allowing the breaker to be closed against a dead short circuit with perfect safety.

A two-pole breaker is used with one pole connected in each secondary line lead, to provide protection on unbalanced three wire secondary loads. The actuating elements are bimetallic strips, surrounded by the same oil as the transformer winding and connected in series with the secondary so the winding current flows through them. Current flowing in a transformer winding produces heat which flows into the oil where it is carried to the tank wall and radiated. This flow of heat establishes a difference in temperature between the winding and oil known as the temperature gradient of the winding. This same current also flows through the bimetallic strips of the circuit breaker and increases its temperature above that of the oil to establish a gradient between the bimetal element and oil. Since these two gradients are established by the same current and to the same body of oil, it is theoretically possible to proportion the resistance of the bimetal and the rate of heat dissipation so that the bimetal gradient will be equal or proportional to the transformer winding gradient. The temperature of the bimetal can be made to follow the transformer temperature (with reasonable accuracy for long periods) so on useful overloads it arrives at the tripping temperature whenever the copper of the winding reaches the maximum safe temperature regardless of the ambient temperature. However, on heavy overloads or short circuits the breaker trips immediately which is advantageous as the transformer is not heated up to its maximum safe temperature. The higher the short

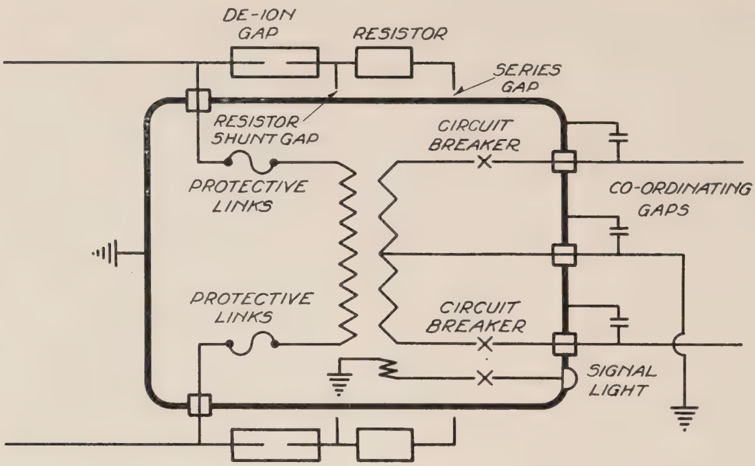



DIAGRAM OF CONNECTIONS OF COMPLETELY SELF-PROTECTING TRANSFORMER

circuit current, the faster will be the tripping.

As shown in the illustration, lightning surges entering the transformer from the primary or secondary side will flash over the de-ion gaps or the secondary bushings and will not pass through the breaker or protective links. These parts are only required to carry the charging current of the winding. The breaker is insulated against surges and co-ordinated with the insulation of the transformer winding. While the A.I.E.E. ruling for coil temperature specifies a maximum of 105 deg. cent. for continuous loadings, it also recognizes that distribution transformers can be operated at temperatures in excess of 105 deg. cent. for considerable periods of time without excessive damage. This fact is taken into account in designing the breaker. Engaging each bimetal are two latches with different lengths. As the bimetal heats up it deflects so that at approximately 100 deg. cent. in the transformer winding the first latch disengages and energizes a signal light circuit. The breaker does not trip until the second latch disengages at a higher temperature depending on the load and time.

### The Signal Light

The signal light is mounted in the transformer tank so that it is visible from the outside. Energy for it is supplied from a small tertiary winding on the main transformer core in order to protect it from surges. If it were energized from a part or all of any of the main windings, surges impinging upon that winding would take the low resistance path through the light and burn it out. By having a tertiary winding or few turns closely coupled with the core and one end grounded to the core, surge voltages induced in the signal light circuit are reduced to a minimum and immunity to surges is established.

The light is controlled by the breaker bimetal which is related to

the transformer temperature. Its purpose is to give a warning signal when the transformer exceeds the safe continuous operating temperature, and thus to eliminate actual tripping of the breaker on cumulative overloads. In this respect it serves as a load-indicating device. It also indicates an open breaker. After lighting it remains lit until reset by hand. This can be done with the breaker operating handle without opening the breaker contacts.

### Fuse Co-ordination

It is important in maintaining continuous service to establish a definite co-ordination of operation between the overcurrent protective devices used in customer's premises, the transformer breaker, the internal links and primary feeder fuses or breakers. It is essential that the transformer breaker not trip out for any loading or fault in customer's premises even when the transformer is loaded and the windings have reached the maximum safe operating temperature. For instance the transformer breakers should not trip on currents which will blow cold 30-ampere plug fuses and 60-ampere cartridge fuses. These are the largest fuses in common use for lighting service and major appliances respectively.

### Protective Links

In conjunction with the secondary breaker it is also necessary to use internal protective links in the h.v. leads to the windings. The only purpose of these links is to protect against a feeder outage in the case of a defect in the transformer windings. The breaker cannot perform this function as it is connected in the secondary winding. This link uses an alloy wire for the fusible element which is of high mechanical strength and impervious to the action of oil. The rupturing capacity of the link is co-ordinated with the secondary breaker and also operates at sufficiently low current to permit selective co-ordination with feeder fuses or line breaker relay settings. As the links only open on an internal fault requiring a major repair to the transformer it is unnecessary to provide means to refill or replace the protective links.

In conclusion we might summarize the distinct advantages built into the modern completely self-protected distribution transformer which provides:

1. Complete self-protection against lightning.
2. Complete protection against service interruptions from fuse outage.
3. Complete self-protection against burnouts from short circuits.
4. Complete self-protection from burnouts from overloads.

While a transformer with built-in protection costs more per kv-a. as first cost, it will be found that installation and maintenance expenses are greatly reduced. Exterior fuse cutouts, fuses and lightning arresters are not required. Installation costs are less because there is less equipment to install. Because of overload protection based on copper temperature completely self-protected transformers can be applied less conservatively and it is estimated that in half the applications the next smaller size of trans-

former can safely be used. Maintenance costs are very much less especially in rural districts where fuse outage is costly. The indicating light is an automatic load indicator which eliminates the need for a load survey. To the electrical utility these modern developments in distribution transformers show definite savings both in investment and upkeep.

# Fluorescence in Ultra-Violet Light

## A New Electrical Tool for the Farmer

By Dr. Julius Grant, F.I.C.

THE applications of electricity to the farm are in no way restricted to its use as a source of power for machinery. The purpose of this article is, in fact, to draw attention to a novel and useful piece of equipment which owes its use in connection with farm problems entirely to the advent of electricity.

The equipment is a new type of ultra-violet lamp, similar to that used for "sun-bathing". It is electrically-operated from a.c. or d.c., and can be constructed in a portable and self-contained form. The use of the lamp is not to provide crops with sun-baths in inclement weather, although this is not outside the bounds of possibility. Its particular use depends rather on the fact that many substances, including soil, plants, and the many other materials associated with agriculture, emit a characteristic glow when exposed to a powerful beam of such radiations. This glow is termed "fluorescence", and its colour and intensity vary according to the nature, and to some extent the amount, of the particular substances under examination; it will be appreciated, therefore, that under suitable conditions it may serve as a useful tool for the investigation of plant and soil problems.

Lamps which provide the type of ultra-violet light most suitable for fluorescence work, with more intensity and more dependability than the sun, are now obtainable at a relatively small cost, and as they can be operated electrically, without special experience, the value of the method is enhanced considerably. The source of radiations is usually a mercury vapour lamp, and although other types of lamp also exist, they are of less importance from the present viewpoint. Mention should, however, be made of a lamp which looks like an ordinary electric light bulb and fits into an ordinary socket. When connected to a.c. mains through a choke and resistance system it produces radiations containing a high proportion of ultra-violet light.

Sunlight contains ultra-violet light and, as might be expected, attempts

have been made to utilize this for fluorescence tests by removing the other interfering radiations by means of filters. Apparatus based on this principle, however, gives only moderate results even under the best conditions and, of course, it is as unreliable as sunshine itself.

Discharge lamps are usually mounted in a cabinet, but portable models are available for use when it is not convenient to bring the sample to the lamp.

These lamps emit a large proportion of an intense blue (i.e. visible) light which must be eliminated by passing the radiations through an absorbing filter. Of the many materials suggested for this purpose, none has surpassed for combined convenience and efficiency the so-called "Wood's" glass. This glass, which is named after its inventor, contains a proportion of nickel oxide; it is dark blue and almost opaque in appearance, and it allows the passage of the ultra-violet radiations responsible for fluorescence effects, the visible and other radiations being absorbed. Since the radiations transmitted cannot be seen by the human eye, they are sometimes known as "black light". These filters play an important part in the method, because if the object is illuminated by visible light, the fluorescence cannot be seen. Many common objects around us, for example, are fluorescing under the action of the ultra-violet light from the sun, but we cannot see this happening because the visible light also present in the sun masks the fluorescence. For this reason too, the test is best made in a dark room, or in a shrouded space.

The applications of this novel method of investigation to the farm fall into three main categories. The first includes its use as an aid to the control of farm operations; the second refers to the checking of the quality of what might be termed the raw materials of the farm (e.g., seeds, manures, etc.); whilst, in the third, the fluorescence is used as a means of differentiating varieties or grades of plants, seeds, etc., which might otherwise be difficult to distinguish.

A good example of the first type of application is concerned with the uniformity of distribution of a fertilizer or manure. In this case a small quantity of a highly-fluorescent substance is first mixed well with the fertilizer. The fertilizer is then applied to the soil in the usual way, samples of the treated soil being taken eventually from various parts of the field and examined in the filtered ultra-violet light. If the fluorescent specks are distributed uniformly in the soil, then it may be assumed that the same applies to the fertilizer. Anthracene has been found very suitable for the purpose, and in this case it is seen in ultra-violet light as pin-points of blue light on an almost black background of soil.

Examples of applications in the second category are very numerous, and here again fertilizers and manures provide good examples. Thus, a bulk sample representing a delivery may be compared with the standard on which the consignment was purchased; or, if the latter is not avail-

able, with a previous satisfactory delivery. Since many fertilizers and manures (and especially those prepared artificially) fluoresce characteristically, differences in composition which might provide the basis of a complaint regarding quality may be revealed. Most phosphatic fertilizers, for example, fluoresce to a greater or less extent; superphosphates appear usually, dull violet in colour; whilst particles of bone meal may be picked out at once by their light blue fluorescence. Here again the test will also indicate both the degree of uniformity of mixtures and the fineness to which they are ground.

Some of the most striking achievements of this type of application have, however, been in connection with mixtures of seeds. The differentiation of seeds as such is dealt with further below, under the heading of applications of the third category and, at the moment, we are concerned mainly with mixtures of seeds, e.g., as used for poultry-foods, etc. The present writer has examined a large number of these, with some very interesting results. The most striking effects were obtained with fine-cut wheat, barley groats, broad-bran and maize meal, which had a vivid white or blue-white fluorescence. Ground oats, however, were brown in colour, and Dutch blue peas were dull purple with vivid blue-white or yellow patches. Limestone grit, charcoal and oyster shell were non-fluorescent. They, therefore, appeared black under the lamp, and the amounts present could be estimated with ease by reason of the sharp comparison with the fluorescent ingredients of the mix. Tares presented a striking golden colour which was so vivid as to render their identification possible when 10 per cent or less was present in the crushed state in a poultry mix. Maples were similar, although more yellow. The quantity of nux vomica added to cattle-cakes as a purgative must be controlled carefully on account of the alkaloids present, and here again inspection in ultra-violet light has proved of value, as it shows not only the amount present, but also whether it is distributed uniformly.

We may now deal with the third type of application of the method; one of the most interesting of these is known as filter-paper analysis. This particular application is based on the fact that when the seeds of certain plants germinate, the rootlets exude a substance which either by itself, or in combination with absorbent paper, is fluorescent. The mechanism behind this process is not fully understood, but nevertheless, since closely-related members of the same family behave differently in this respect, one has simple means of carrying out what might otherwise be a very tricky differentiation. Probably the best example is concerned with the perennial rye grass *(Lolium perenne, L.)* and Italian rye grass *(Lolium multiflorum Lam.)*. If the terminal awns of the latter are present, differentiation is not difficult, and the aid of ultra-violet light is unnecessary. If, however, the seeds have been machine-dressed the awns are removed. The method then adopted is to allow batches of the seeds to germinate in a warm moist atmosphere on a sheet of a good

grade of white absorbent paper. The roots develop after four to six days, and on examination of the papers under the lamp, a blue fluorescence is seen surrounding the portions of the paper in contact with the rootlets of the false perennials, whilst those of the true perennials show nothing. Other similar instances are on record, and the method appears to be capable of wide applications; work on oats has, in fact, already been carried out.

The fact that markings on solid surfaces which are invisible to the unaided eye may often be revealed by ultra-violet light, has been used to detect signs of incipient mouldiness or attack by other organisms on the surface of seeds. The method is therefore of value when seeds are being sorted individually, although, of course, its application is limited to those types of defect which happen either to produce fluorescent products, or else to affect the surface of the seed so as to modify its natural fluorescence. In this way the presence of bacteria and fungi on seeds of *Phaseolus vulgaris* taken from store or on tobacco have been demonstrated. Similarly, the normal fluorescence of peas is replaced by black or bright-yellow spots as the result of storage under damp conditions.

Some better known applications refer to the examination of eggs. The normal fluorescence of an egg-shell is red to purple, but it has been shown that as the egg ages this changes in many cases to blue, and then to colourless. Under certain conditions, therefore, it is possible to use this change as a means of estimating the age of eggs, although the indications must be interpreted with caution where eggs of unknown origin are concerned, because the rate of change varies somewhat according to the breed of fowl. It is, however, very unlikely that an egg which has a red fluorescence would be more than one week old; or, what is more important, that a colourless egg could be considered as "new laid". An isolated dark patch seen on observing the shell in ultra-violet light is an indication that a "mark of origin" has been removed, and so far as the writer's experience goes, no method of removing these marks fails to produce this tell-tale evidence. Under certain circumstances a scoured egg may be recognized from the patchy fluorescence of the shell. Promising results have been obtained in the detection of eggs which have been preserved in water-glass, by staining the shell with a dyestuff which produces a fluorescent effect with the alkali left behind in the pores of the shell by the preserving-agent. Attempts to estimate the age of an egg from the fluorescence of its contents have not been altogether successful, and indeed the usefulness of any such method is greatly diminished if the egg has to be broken in order to apply the test.

A reference should be made, in conclusion, to a recent development which, even if it cannot be applied by an untrained operator, offers wide scope in certain branches of agricultural research. This is known as fluorescence microscopy, and it is based on the fact that if a specimen (for example, a cross-section of a

seed), is examined under the micro-scope with filtered ultra-violet light as the source of illumination instead of visible daylight or lamplight, many structures which are normally invisible or difficult to see are revealed by their fluorescence. This applies particularly to structures containing starch or oils. Furthermore, the specimen may be stained with substances which impart fluorescence to certain of the structures, and in this way the range of the method is widened considerably. Developments such as these place a powerful weapon in the hands of the plant investigator, and one which, in the long run, must serve in the general interests of practical agriculture. — *Rural Electrification and Electro-Farming.*

## Quarterly Bulletin of the Electrical Inspection Department

The Quarterly Bulletin of the Electrical Inspection Department of the Hydro-Electric Power Commission of Ontario has been issued recently and sent to all electrical contractors, jobbers and interested manufacturers. Though intended for quarterly publication, should occasion demand there may be special intermediate issues. The purpose of the Quarterly Bulletin is to advise electrical contractors and manufacturers of changes in the electrical code and to interpret rules which the Chief Electrical Inspector considers to be of insufficient importance to require an official interpretation through the C.E.S.A. Copies may be obtained by application to the Electrical Inspection Department.

LAID:

An egg on the electric stove in the Public Utilities Building in Blenheim, Ont. Several days ago a pigeon was found sitting at the entrance to the Public Utilities Building by an employee who took it inside. It was quite tame and, after being fed hopped over to an electric stove and laid an egg. After it had abandoned the egg, the bird was allowed its freedom. A day or so later, it returned. It sat in front of the office until the door was opened, then flew in, lighted on the stove and deposited another egg. Now employees of the Blenheim Public Utilities are trying to convince sceptical listeners that the bird thought the electric stove would make a good incubator.

—*Toronto Saturday Night.*

THE
# BULLETIN

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# NEW BUSINESS

By M. J. McHenry, Director of Sales Promotion,
H. E. P. C. of Ontario

*When delivering his address, Mr. McHenry illustrated it with lantern slides. Those slides are of such a nature that they cannot be reproduced satisfactorily here and therefore have been omitted. All of the information shown on the slides is contained in the address excepting of those illustrating exhibits and forms of advertising which have appeared elsewhere. —Editor.*

ON behalf of the Sales Promotion Department of the Hydro-Electric Power Commission, let me express keen appreciation for the interest and the co-operation which we have received this year from the various municipal systems throughout Ontario. In most cases we have been given a very hearty reception. There has been a great deal of interest displayed in what we had to suggest, and such interest has usually resulted in splendid co-operative work. We appreciate this, and we hope that as time goes on the municipal Hydro-Electric systems of the Province will be working with us a hundred percent.

May I first remind you of some of the projects which we had in mind for the promotion of new business. Primarily, the Commission's interest in sales promotion work is to build Hydro, increase the load of the Ontario system, and to increase the loads and the revenues of the various municipal systems and rural power districts. But there are other features of sales promotion work which may have been lost sight of in trying to build load. Some of these principles we are trying to incorporate in our program and many of them have been incorporated with a high degree of success.

One of these ideas is the question of building good-will — public relations, if you please. The problem of public relations is an important one to any utility, no matter whether it

Address delivered to the Ontario Municipal Electric Association and the Association of Municipal Electrical Utilities at Ottawa, July 5, 1939.

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Vol. XXVI No. 8
August, 1939



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

be electric, water works, gas, or any other form of public supply, and the questions of sales promotion and public relations go hand in hand.

Consequently, a great deal of our advertising has been directed toward telling the story of Hydro to the people of Ontario, and advising of the services that Hydro can render and does render, in order to establish the highest possible degree of good relationship between our consumers and the utilities.

Then, of course, another feature of the program has been to acquaint the public with the advantage of the use of electricity, and the many ways that it can be used economically; to stimulate the public purchase and use of electricity. By many ways, the electric industry itself has been encouraged to greater effort, through co-operation, through stimulation in the selling of all types of equipment which will increase load. Hydro municipalities have been encouraged and assisted to increase their load and consequently effect economies and greater revenues.

At the Convention in February we outlined an advertising program. I would like to give you a brief picture of what has been accomplished in connection with advertising. In order to bring this to your mind in the simplest and quickest possible way, we will use lantern slides. The first slide has reference to the Institutional Advertising campaign. To carry out this form of advertising, and to contact as many people as possible, particularly people in an executive capacity in business and industry generally, we have so far this year conveyed, through the media of the various papers shown (Gold, Monetary Times, Financial Post, Northern Miner, etc.) a total of 666,224 messages.

The term "messages" is a comparative figure obtained from the circulation of these papers, multiplied by the number of advertisements that have been placed.

The result has been a steady bombardment of the public with this institutional advertising.

Two typical advertisements having been used in this campaign are shown. There was a series referring to the various industries throughout the Province. The first one shown refers to the agricultural industry, and the other refers to the research and development work of the electrical industry.

Other industries, such as the steel industry, the automobile industry,

and the textile industry were discussed, pointing out in all of this advertising the large part and the important part which Hydro plays in connection with all these major industries.

The other form of institutional advertising has been the radio program which was broadcast for thirteen weeks during the late winter and early spring. This present slide shows that we have broadcast across the Province of Ontario to over 635,000 listeners every week for thirteen weeks.

No claim is made that all the 635,000 listened. We do not know how many listened, but we do know that this was the coverage of the various radio stations which were used. From some of the letters which we have received, from listeners, we have a general feeling that the program was reasonably well heard and that it was appreciated.

In that respect, while we have had a number of letters from consumers and listeners, generally, we have not received any suggestions, or any comments from any municipality that I can recall at the moment. We would very much like to have, in the course of the next month, comments from the various municipal systems with reference to radio programs, so that we may be guided in establishing the continuing programs which will operate for thirteen weeks, commencing the end of September.

Now, let us touch on another phase of advertising work, the range campaign. I think everybody has been acquainted with the range campaign that was put before you at the February Convention, and that has been carried forward since that time by our promotion field men. It has been very interesting indeed, to find the number of municipalities who have taken up active work in the sale of ranges and they have been responsible for a decided increase this year in the total number of ranges sold.

The next slide shows that for the first seven months of the 1937-38 fiscal year, i.e., from November 1st to May 31st, we had 4,591 ranges reported as installed. This year, 1938-39, there were 5,260 ranges reported installed, an increase of 459 ranges, or approximately 15 percent.

The 4,591 ranges in 1937-38 represented 45 percent of the total ranges installed in that year.

It is only fair to assume that the same condition will obtain this year, and accordingly, we should have approximately 11,700 ranges installed this year, or close to 12,000 ranges. This is an increase of approximately 20 percent for the year.

I think we can very safely say from those figures that effective work is being done by the whole industry, and particularly by the municipalities who have entered into this range campaign. Likewise the work which is being done in the rural power districts is having an effect and is producing results.

In connection with the range campaign, there are a few figures which will be interesting to the municipal systems. They relate to the financing of electric ranges.

At the present time, our reports show 78 municipal systems who are financing ranges. Of this number, 33 are financing ranges for dealers in their municipalities, as well as for themselves.

The maximum term period that is being used is three years, and the average rate or interest charge is 4⅓ percent.

In this connection, the financing charge runs all the way from 2¾ percent in one municipality, up to 6 percent in another municipality. We believe that it would be a very splendid idea if we could arrange to have the various municipalities working on a similar financing rate. It is not a serious situation that they are not, but it would be to the advantage of all concerned if we could use the same financing rate. We suggest 4 percent.

Of these 78 municipalities, 71 are also allowing or making provision for three-wire range wiring, free of charge. That is, they are assuming the cost of three-wire service to the service box, and 20 are assuming the cost of range wiring only, that is, from service box to the range.

Of those who are paying the cost of the three-wire wiring, 16 only are financing the cost of the wiring.

It is felt that it would be an advantage for any municipality that is financing the sale of ranges and who is supplying the wiring without charge—the financing of wiring is unnecessary, but where it is not being financed, it would be an advantage to at least finance it along with the range itself.

Also, 18 municipalities are making some allowance for used ranges, of a type other than electric, that are taken out and replaced by new electric ranges with added load to the system.

In a good many sections of the country where we have very active gas competition, it is almost essential that some allowance be made for used ranges, in order to compete with the gas companies in such locations, and I believe that more of our municipal systems should give serious consideration to this feature.

A great deal of active co-operation has been engendered with the dealers and their organizations in various municipalities, and this is indeed very encouraging.

As many of you know, in many places, the dealers have been somewhat antagonistic to Hydro operation of merchandising systems, but we find in a great many localities, through the media of range campaigns, the financing of dealer sales, the Demonstration Week activities, and other activities of a similar nature, a high degree of co-operation between the municipal system and the dealer has been inaugurated. Let us hope that it will be self-continuing and beneficial.

May we look for a moment at the high light of our spring activity—Electric Demonstration Week. Electric Demonstration Week was taken up by quite a number of municipalities, and in most cases has been successful.

Electric Demonstration Week has produced three main results. In the first place, we are definitely assured that public-consciousness was awakened, and that it has had an effect, a very decided and favourable effect on the sale of electrical appliances.

Another thing that has been accomplished through Electric Demonstration Week has been the encouragement and stimulation of the electrical trade.

During the last month or six weeks in discussing with dealers here and

there throughout the Province their reaction to Electric Demonstration Week, they have been more or less satisfied with it. They have felt that it has been a worthwhile effort and that it has reacted both to their own interest and to the interest of the utility.

This campaign has laid the foundation for further co-operation with dealer organizations, giving us the opportunity to help the electrical dealers to do a better job than they are doing at the present time, and to educate them in many ways.

Possibly we have too much lost sight of the fact that the electrical dealer or the merchant who is selling electrical appliances throughout the Province is, in essence a salesman for the Hydro-Electric system, because any electrical appliance which he sells consumes electric power and provides additional revenue to the Hydro system in that community. So we cannot overlook the fact that any bona fide dealer of electrical equipment is essentially a salesman of our power. If we can do anything at all to improve his position, to encourage him to sell more equipment and to help him to sell more equipment, then we are aiding our own business as well.

May we have the first slide in connection with Electric Demonstration Week. I do not think this needs any comment. These are some of the promotional pieces used in connection with this Week, and you are all familiar with them.

Our next slide gives an indication of the advertising placed by the Commission during Electric Demonstration Week in the daily papers listed. As indicated at the bottom, through the media listed there were delivered to the people of the Province over 5,000,000 messages. I think you will appreciate that the appearance in all of the daily papers in the Province of these 5,000,000 messages must have had some effect.

The next slide is just a view of the display floor at the National Electric Show held at the Maple Leaf Gardens in Toronto. The first one of the Demonstration Week series opened in Toronto and I am happy to say to you that the Show in many ways was successful. It has already been suggested and recommended in several quarters that it be repeated next year. Further the Show actually operated within its receipts, so we were able to return a dividend to all the subscribers of approximately 2 percent. I think that was a rather good effort for the first attempt.

The total attendance at that Show was approximately 20,000 people. If there had been any more we could not have accommodated them acceptably. Much interest was displayed there and we believe it has had a decided effect in Toronto and also in the Province.

One of the things that has come from the Electric Demonstration Week activity is that in many localities there are now dealer organizations working with the Hydro-Electric systems, instead of pulling apart. If these can be maintained and carried forward, we are sure that the result will be satisfactory to all concerned.

There are a few points in connection with the rural campaign which I would just like to mention. Possibly the municipal men who are commis-

sioners and managers of municipal systems are not so keenly interested in the rural power districts as we are, but I believe there are two reasons why they should be interested in this operation which is being carried forward by us in the rural districts.

In the first place, the more load we can produce in the rural power districts, the better the reaction with regard to the municipal system itself. If the rural power district can be made to operate with a high saturation, a good load, and on a very economical basis, it is bound to have a reaction on the total cost for the municipal systems.

In addition to that, we have found since our travel coach has gone into operation in the field that we are able to combine promotion work in the rural power district with promotion work in a great many of the smaller municipalities. It has been very encouraging to find we can tie them together in the field and advertise to both the local municipal system and the rural power district at one and the same time.

In the rural campaign, the first slide gives you an indication of the advertising which has been used. Good use has been made of the farm magazines (Farmers' Advocate, Family Herald and Weekly Star, Canadian Countryman and Ontario Milk Producer). So far we have sent to the farmers of Ontario a total number of messages amounting to approximately two and a half million.

This advertising has been one of the most effective campaigns we have had. Considerable and favourable comment from farmers all over the Province has been received. In addition, many of our rural merchants tell us that the farmers are remarking to them when they talk about some particular piece of equipment that they saw it advertised by Hydro in some farm magazine. So the farmer is reading this advertising, and we are sure it is having a beneficial effect.

Next is shown a sample of the advertising which is being used. Please note that we are making an appeal to the farmer based on the economy in the use of electricity on the farm. We indicate the various operations, and give the farmer some information of the low cost under which the operations illustrated can be carried out. This seems to be an effective way of sending our message to the rural areas, and, judging from the replies we have had, it would seem that we are on the right track.

The next slide illustrates two typical farm advertisements which have been used. One deals with refrigeration and milk cooling, and the other with electric cooking.

In the next slide is shown two pages of a new farm publication which is being produced at present, and will shortly be distributed. This publication was made up particularly for the benefit of the farmer, and will help to tell him the story of the use of electricity on the farm, to supply information on how it can be used to best advantage, and at low cost. It will also contain wiring information and suggestions as to the best method of procedure in acquiring the services of Hydro.

Our rural coach started out in February and March. The weather and road conditions were such that it was not possible to start with a regu-

lar program throughout the rural power districts, so we confined its operation for those two months to display work in many municipalities throughout the Province, obtaining very excellent results.

During that time we covered fourteen towns and cities and approximately 7,500 people visited the coach.

During April, May and June, the coach has been on a regular schedule throughout the western part of the Province, and has covered a total of 29 rural power districts, with 47 demonstrations held. The total attendance has been approximately 13,000 composed of people both from the smaller towns where it has been located, and from the rural power districts.

Next we turn to another phase of our activity, namely industrial and commercial applications. This is a rather difficult type of work to carry out, and progress is slower. Two ideas have been kept in mind, first, to assist the municipal Hydro systems to maintain their present loads and to obtain new loads from all industrial and commercial customers, second, to establish a closer contact between Hydro and industry, by providing for a systematic contact and aggressive selling of all uses of utility service to commercial and industrial customers, and by continually bringing to the attention of industrial and commercial customers new or improved electrical equipment or new methods of manufacture involving increased use of electricity.

The industrial and commercial section has been actively engaged on industrial work since the close of the Electric Demonstration Week campaign, about the end of May. During this short time our field men have contacted various industrial and commercial plants, and the favourable reception received indicates that there is a very definite need for the service which this section can give. Several of these calls have already resulted in additional electrical equipment being installed.

Special attention is being given to electric melting of gray iron in the various foundries throughout the Province, and to atmosphere controlled annealling furnaces. We are now dealing with a proposition which if it can be carried forward, will mean a load of approximately 1,000 kilowatts using this type of equipment.

Our commercial advertising program has been largely directed at commercial institutions, stressing commercial cooking, air conditioning and lighting.

On the next slide is shown the media which we have used in this advertising campaign. The total number of messages which have been sent out through the media of these magazines has been approximately 200,000.

Along with these we have used a certain number of industrial magazines illustrated on the next slide, giving a total of approximately 155,000 messages to industry.

Next are shown two samples of the advertising used. One dealing with electric heat, and the other a tie-in with the engineering professions in order to stimulate greater interest in Hydro.

Our industrial engineers are now contacting the various Hydro systems throughout the Province, and we desire to be as helpful as we can to

every municipality in dealing with industry. If you have any power problems that we can help you to solve, we will be very glad to co-operate. We also hope that you will assist us in getting in contact with the industrial users to whom we may be able to point out additional and improved uses of electricity.

So far this year, we have not stressed flat rate water heaters. Possibly the remarks which Dr. Hogg made last evening indicate a reason why we have not been pressing water heaters. The water heater campaign has gone ahead so far by its own momentum, but we are now developing a new bulletin devoted to water heating problems.

The next slide indicates some of the advertising that will appear in that bulletin, for your use. This bulletin follows along the same lines as the range campaign bulletin with sample advertising and cuts provided for the use of individual municipal systems in their local advertising.

Much of this advertising has been put forward with a very personal appeal in respect to the necessity for hot water.

Incorporated in this new campaign are a couple of new and optional items. There has been in many localities difficulty resulting from the use of iron tanks which are comparatively short lived. So we are bringing out in this campaign optional items with respect to non-ferrous tanks.

Arrangements have been made whereby the non-ferrous tanks may be obtained, and we are suggesting in our bulletin two or three ways by which the sale of these tanks can be handled. We believe there should be quite a number of people throughout the Province who will be glad to have the iron tanks replaced with a non-ferrous tank.

In this bulletin, we are also illustrating other advertising material supplied on request, for your use.

This slide shows a floor display similar to the range floor display. We suggest that this floor display which stands about 48 inches high be used on the floor of your Hydro shop or office, standing beside a sample water heater and tank installation.

Supplementing the floor display is a small mailing piece which can be supplied in reasonable quantities to all the municipal systems to mail with letters or hand to Hydro shop customers.

Further, there is a smaller display card for use on counters, cashiers' cages and similar locations, calling attention to the Hydro flat rate water heater.

These pieces will, I expect, be ready in the course of the next several weeks, and we hope that the municipal systems will be glad to undertake added efforts in respect to hot water heaters.

We now come to a rather interesting phase of promotion work, commercial lighting. The indications are that commercial lighting is one of the very outstanding means by which we can increase the sale of power, give an added service to our consumers and add profitable revenue to the municipal systems.

As you are aware, work in connection with commercial lighting has been carried on by the Commission for one year. It was started about the first of June last year, and was

incorporated in the Sales Promotion Department in the late fall. Some of the results obtained in this work so far will be of interest.

In one year, commercial lighting surveys have been carried out in 50 municipalities. In 15 of these actual demonstrations have been installed in stores. The total number of individual demonstrations, however, has been eighty-one.

Following these surveys, we have issued to commercial customers throughout the Province 496 recommending reports. In addition, we have issued 125 reports on requests coming in unsolicited, making a total number of reports and recommendations on improved lighting of 621. The final total load on these reports was 4,255 kilowatts. The original load was 1,350 kilowatts and the resultant increase 2,905 kilowatts.

The revenue from such increase in load is estimated at an amount of $103,000 based on an average rate of 1.7 cents per kw-hr. and 100 percent completion of the recommendations submitted. I have shown that the cost of carrying on this work was at the rate of $25,000 per annum.

But, I would like to point out that this was for only six months of the year. It was an introductory period, the establishment of a process of doing something. Only in the last few months has it actually gotten under way productively.

An interesting item is that we are now prepared at approximately the same cost per year, to handle probably three times as many reports as are indicated here, resulting in approximately three times the increase in power for the same cost.

That is why this commercial lighting activity appears to be a very successful one. I sincerely hope every municipal system will become interested in having surveys conducted and in following this work in their own municipality. It is the quickest way to increase revenue.

To indicate to you what some of the consumers throughout the Province think of this service, I would like to read two letters which we have received. The first is from a haberdashery shop and men's clothing store, written to the Sales Promotion Department as follows:

"We have intended for the last few weeks to express our thanks for the assistance your Department gave us in the installation of our new lighting system.

"One of the important items we have found with the new lights is the complete absence of any eye strain. Formerly, when the old style lights were on for any length of time, our eyes got quite tired, but now the store is brilliant with light, but you really have to look up at the lights to realize that light is coming from them.

"We have had very many comments from customers on how bright the merchandise looks. You will realize what a compliment this is when this is said about men's wear. Cloth, we imagine, is about one of the hardest things to see under artificial light.

"In short, we feel the new lighting system is the best improvement we have ever made in our store, and one of the least expensive for the value we are receiving."

The last sentence brings out the

average consumer reaction to this commercial lighting endeavour—"One of the best improvements made in the store, and one of the least expensive for the value we are receiving".

Here is another letter from the School Board of a municipality in Western Ontario:

> "I have been instructed to express to you the sincere appreciation of the Kingsville Public School Board for the wiring and lighting plans and specifications prepared by you for the installation of lights in the senior school.
>
> "In calling for the tenders for the installation of these lights, although an attempt was made to have your recommendations altered, the Board insisted that the plans submitted by you be followed without variation. Since the wiring is completed and most of the lights installed, the excellence of the results attained clearly proves the wisdom of following your recommendations.
>
> "Permit me to again express our gratitude to you for so guiding us in this matter that the results have proved eminently satisfactory."

We have been so encouraged by the receipt of these and similar letters that we feel that here is a very valuable means of doing several things—increasing load, increasing revenue, increasing good will, and rendering a service to the community, as well as to the various merchants in that community.

During the last several months, considerable advertising has been presented in the daily papers of Ontario covering Hydro lamps. Through the media of the daily papers we have endeavoured to advertise to the public the value of a lamp developed for the particular needs of Ontario. Close to 6,000,000 individual messages have been placed before the people of Ontario during this period.

In addition, some municipal systems have also advertised Hydro lamps locally, but the volume of this local advertising has been indeed meagre. May I suggest to you the value of increased presentation to the public of the story of Hydro lamps?

Many municipalities are not now attempting to merchandise the Hydro lamps, but there is no reason why any municipality cannot sell Hydro lamps, even if they have no Hydro shop. It is not a difficult proposition, nor is it necessary to maintain either a costly or an expensive staff. Yet the people in your community can be served exceptionally well by providing them with the availability of the Hydro lamp which has been designed and built for their best and economic service. I would like to leave that thought with you for further consideration, and I hope that many systems will undertake to extend the sale of Hydro lamps.

So far, there has been little activity in connection with home lighting. This is a rather difficult type of campaign to undertake, and it will require the very sincere co-operation of the municipal systems to attain any success. In its usual form of operation in the past, the costs of operation have been very high in proportion to the results obtained.

Recently, we have had the opportunity of seeing a campaign which is under way in the country to the south of us. We believe that the

municipalities of Ontario could carry this on at low cost and yet in a very productive way. It is a home light conditioning program, and it does not necessarily necessitate home canvassers, although these could be used to advantage, but it does provide a means by which we can increase the lighting load in the ordinary residence, and can do that very effectively, and at low cost to the consumer.

Many types of equipment have been developed within the last year, which enable existing equipment in the home to be used and used to advantage, but with improved lighting, higher wattage lamps, and giving lighting according to the "Better Light, Better Sight" program.

In the United States, at present, the average sale of this equipment to the individual home is about $17.00 per residence, including a Trilite lamp. That is not a difficult sale to make, and it usually takes care of the living-room, the kitchen, possibly one or two bedrooms. The average increase in wattage resulting so far has been about 440 watts per residence.

Now, we would like to see this started this fall in Ontario, and we have a display here today of a demonstrating equipment which can be supplied to Hydro shops and Hydro municipalities if they wish to use this equipment to bring before the minds of their customers the type of equipment we have in mind. Further, it explains the advantages to them of improved lighting in the home.

At this point, I have pleasure in asking Mr. G. G. Cousins, our Specialist Lighting Engineer, to demonstrate and explain the Home Light Conditioning equipment.

(Mr. Cousins demonstrated the stand described in an article by him "New Effects from Old Fixtures" on page 241 of this issue.)

This brief explanation of the type of equipment will illustrate the ideas we have in mind. We are very much interested in having the comments of the various municipalities, particularly those who operate Hydro shops in respect to merchandising with this type of equipment and using a merchandiser somewhat of the type shown. We would be most happy if you will write us or advise us as quickly as possible if you like it, and if you would like to have this type of equipment. This equipment is nearly all available in Canada at the present time, and we will be glad to arrange for you to obtain this type of equipment through us or direct from the manufacturer.

This idea can be amplified to a very great extent, because municipalities who desire to have a home lighting advisor can make arrangements through us to have such a home lighting advisor trained in selling this equipment. Or, if you have salesmen who are selling equipment from your Hydro shop now, calling on consumers and residential prospects, they can also sell this type of equipment very advantageously. Arrangements can be made whereby kits can be supplied so that they can carry the equipment with them.

One of the advantages of this type of merchandiser is that it interests people coming into your Hydro shop or office. Enquiries are started and these can very easily lead to an improvement in their home lighting by a reasonably economical method.

This morning, we have tried to indicate something of what has been accomplished this year. We still have a considerable advertising schedule to carry forward before October 31st. We will then arrange a new schedule for 1939-40. In the meantime, we would like very much to have your suggestions and comments to aid us in future planning.

The final slide which I now show points out that so far this year we have bombarded the people of Ontario —industry, retail business, manufacturers, executives and the public generally—with fourteen and one-half million Hydro messages. I think you will agree with me that these messages, going forward to all classes of people in the Province, carrying the story of Hydro, stimulating the public mind to the use of Hydro, and telling the story of its economies and its services, are bound to have an effect and an accumulating effect which will be felt in greater and greater degree in the future.

In this paper this morning, an attempt has been made to review promotional activities carried on during the first six months of the present year. A convention of the type of this present one presents an excellent opportunity to give such a report, but it is felt that there should be some means by which an interchange of ideas could be effected at regular intervals during the course of the year. In order to bring about such a result, the idea of having a sales promotional magazine has been developed.

Such magazine has been produced and is ready for distribution to you this morning. It is expected that further issues of this publication will be made at regular intervals and distributed to the municipal systems, the rural power districts, and the various departments of the Ontario Commission. In this publication it is planned to present information with reference to sales promotional activities, to effect the interchange of ideas and to generally publish human interest stories, statistics, and other matter which should be of interest to those receiving it. By this means, we hope to keep the Hydro organization as well informed as possible on load building work, and to stimulate the promotion of our business considerably.

In the first issue of this magazine, we have adopted a provisional name "The Ad-Watts". The name refers, of course, directly to our activity, namely, adding watts to the system load, and at the same time, symbolizes advertising. When you receive your copy of this issue, you will note that we have presented an opportunity to comment on, or suggest some other name for the publication. It is hoped that you will take a sincere interest in this, as we desire this magazine to be as much as possible for your service. Your contributions to the contents of this publication from time to time will be fully appreciated, and articles, interesting photographs, and promotional stories will be welcome. The Editor-in-chief of the magazine is Mr. W. C. Dymond of the Sales Promotion Department, and all material for publication should be forwarded to him.

Gentlemen, sufficient time has not elapsed since the formation of the Sales Promotion Department to present such complete information as to

evidence the value of promotional work. This present paper may, therefore, be considered as a progress report. We would like to point out that returns so far give every indication of valuable results, and it seems assured that these results will become more apparent and have greater magnitude as the work proceeds.

We have appreciated very highly the interest and the co-operation of the majority of the municipal Hydro systems throughout the Province. Such interest and co-operation have been a source of encouragement, and I am happy to have this opportunity of expressing on behalf of the Sales Promotion Department, our appreciation for this encouraging attitude on the part of the municipalities.

Our staff is now in the field, and we are making such arrangements with regard to the coverage effected by our field men so that each municipality will have a definite contact man on sales promotional work, who will call on them regularly. We solicit your further co-operation with our work, and in turn, we desire to be as helpful as we possibly can.

# New Effects From Old Fixtures

Geo. G. Cousins, Supervising Lighting Engineer, H. E. P. C. of Ontario

COMPARATIVELY few people realize to what extent the home is a workshop for the eyes. The result is that too often the needs of the eyes are neglected while the esthetic requirements are given first consideration although they are second in importance.

There are three common faults of home lighting, namely:

Insufficient intensity of illumination.

Poor distribution of illumination.

Glare.

Briefly stated, there should be reasonably high intensity localized lighting at chairs, desks, or other places where the eyes work, supplemented by general lighting of somewhat lower intensity throughout the room. It is not necessary to sacrifice esthetic effect in order to obtain these desirable results. One obstacle that has stood in the way of good lighting in the home is that people who rent their homes are not inclined to buy new fixtures for supplying good quality general illumination.

The glare problem from overhead fixtures has been attacked in many interesting ways, such as the use of coloured lamps, shades that absorb all the light, and keeping the lamps turned out. In any case the lighting is practically obliterated.

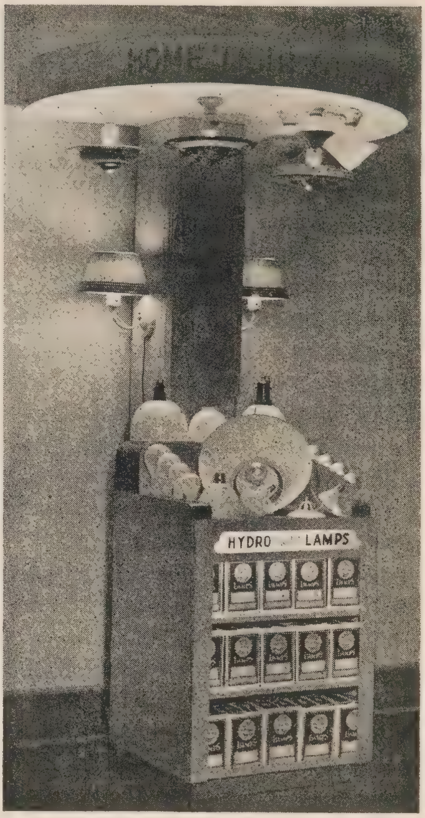
Lamps of the I.E.S. types produce good local lighting and a good amount of general lighting for small rooms, and they should be used to supply the principal lighting for reading and

other similar tasks. However, individuals have their own ideas as well as financial circumstances, and a variety of means for improving home lighting is necessary.

The silvered bowl lamp is, in itself, an indirect lighting unit, and its characteristics provide new, simple, and inexpensive means of producing many improvements in home lighting with old fixtures. Several adapter units for silver bowl lamps have been designed that make possible the conversion of the common single lamp, the cluster, or shower fixture, into indirect fixtures, and the old style bridge lamp into a really efficient lighting unit. For the single lamp fixture the adapter unit is screwed into the socket and the silvered bowl lamp screwed into a socket in the adapter. They are made for several sizes of lamps. For the shower or cluster fixture, silvered bowl lamps, 60 or 100 watts, may be used, and ornamental attachments clipped on to the lamp bowl and held by springs.

The adapter for old bridge lamps includes a white enamelled reflector which, with a silver bowl lamp, produces high intensity local lighting. For ping pong or the work bench in the basement, or elsewhere, a small RLM reflector with silver bowl lamp produces excellent indirect lighting.

These adapters all overcome the faults of older fixtures and lamps by producing good distribution of illumination free from glare. The silver bowl lamp should not be used without some means of shielding the upper part of the bulb, because the light scattered by the frosted neck of the bulb would cause objectionable glare.




*Display stand of Home Light Conditioning equipment.*

The illustration shows a number of these units and associated articles, including adapters for converting old portable lamps into lamps of the I.E.S. types. Stands of the type shown have been found to immediately arouse interest and greatly increase the sale of the articles shown. This stand was constructed for the recent convention at Ottawa, and the display aroused a great deal of interest. Many of the delegates enquired regarding the cost and details of the articles shown. Full details will be made available as soon as possible.

# Substandard Transformerless Radios

SOME radio manufacturers in the United States are producing a type of transformerless radio set which sells for less than $10.00. A number of these have been brought into Canada by visitors. After examination of such sets, the Commission's Approval Laboratory has *condemned them as unsafe*. Consequently, the sale or use of such equipment is illegal in Ontario.

A few of the substandard features are:—

1. They have a resistance for reducing voltage to the tube filaments incorporated in the cord, which overheats and destroys the insulation on the wire.

2. No attempt is made to enclose the tubes or metal parts. These invariably are alive and a severe shock or burn may be obtained from them. This condition is present in all unapproved, substandard, transformerless, American-made sets, and in some it is more pronounced. If any one of the small condensers in a set becomes defective, as often happens on the unapproved sets, it becomes especially hazardous.

3. The aerial connection is very often alive so that extreme care must be taken not to attach the aerial to a radiator or grounded object. It is for this reason that the manufacturers warn the user not to connect them to a radiator.

The points outlined above must be corrected before such a set will be safe for use, and there are likely to be other minor features needing modification. One only needs to look at the construction of these cheaply-made radio sets to realize how easy it is for something to go wrong. Actually, their life is very short and the sets not being legally saleable here they cannot be serviced locally. Some of the tubes used cannot be bought in Canada.

The sets do not carry the approval of the Underwriters Laboratories Incorporated, which is the recognized laboratory in the United States.

The Canadian Engineering Standards Association has brought out a specification covering transformerless radios, and manufacturers in Canada are making small sets similar in appearance to those made in the United States. Canadian companies, even those whose parent companies are in the United States, find that they cannot make a set which is considered safe and meeting necessary requirements so as to sell at the price of the unapproved American sets. When we consider the short life of the unapproved radio sets and the difficulty in obtaining repairs for them, it would appear that the purchase of the more expensive, approved, Canadian equipment is really the more economical.

# Guided Discussion

## Questions Discussed at Convention at Ottawa, July 4th and 5th, 1939

1. Is it advisable to take court action when a customer is found stealing current?

*Mr. O. M. Perry, Windsor:*—Our first consideration in answering this question is what can be gained by taking court action and the ultimate results. No court will tolerate being made a collection agency so we must consider that it will not guarantee remuneration for the service stolen but the most we can hope to attain is a conviction that will serve as a warning to other consumers who may be stealing electricity unknown to us. It is merely the jurisdiction of any court to hear the evidence and decide whether or not a crime has been committed and if so, impose the penalty in accordance with the law.

To obtain a court decision, it is absolutely necessary to supply positive proof and also be in a position to attach the blame or responsibility to some one individual who is to be charged with the theft. This is a difficult task as in the majority of cases, our evidence is purely circumstantial and while it may be strong, it is not sufficient to obtain a conviction. There is always a loophole or alibi of the accused to shift the blame to some unknown person who will not be available at the time of the court action and definitely deny any knowledge of the crime. The result as a rule, is dismissal of the case and the possibility of adverse publicity which will only act as encouragement to others committing similar offenses when they see that it is difficult to obtain a conviction.

It is not suggested that we ignore cases where we find evidence of tampering but we might give our own experiences as a possible solution.

When we have reason to believe a consumer is stealing, our first step is to install a meter unknown to the consumer, on the pole where the service leads to this particular residence. This enables us to obtain an actual registration of the consumption for comparison with the meter installed in the house and will not only establish whether there is a theft of service being committed but will also give a definite proof of the amount stolen over a given period and this is absolutely essential regardless of how you wish to deal with the case.

After obtaining our evidence, we interview the consumer and while we have yet to find one that will admit any knowledge of the findings, as a rule, they are ready and willing to settle for a stated amount, and have learned a lesson that will be long remembered.

Since the act of stealing electricity generally runs in groups and is usually started by some one person advising the others as to how it can be done, we believe that in settling our own cases by a flat charge, sufficient to adequately reimburse us, the in-

formation as to what happens when they are caught is soon passed along to the others as a warning.

* * * *

2. Can the installation of off-peak control equipment for flat-rate water-heaters be justified for reasons other than the saving in power costs?

*Mr. R. L. Dobbin, Peterborough:*—As you know, we have recently installed in Peterborough off-peak water-heater control. We got it installed partly in May and we have just finished installing 1,100 controllers last month. We haven't had much experience with it yet. Theoretically, there should be some saving in distribution losses, when you switch the water-heaters off.

We attempted to determine with a meter installed on each circuit. We have nine circuits controlled and by switching off the water-heaters and watching them drop off the peak we thought we could determine whether there was any extra amount of load dropped off the calculated water-heater load. We tried this out last week and we found that the scale on our graphic meters was not large enough and we were only able to determine the load drop was about equal to the calculated water-heater load.

Several things interfere with it. There is the fact that water-heaters are rated at 115 volts and you might have 125 on that part of the circuit at that time, and therefore the calculated amount of load is not right.

Then there are other things that come in. There is the fact that the thermostat might have water-heaters cut off, because the water is much warmer in the water-main at this time of the year. When you have 70 degree water in the mains the water heaters are not working as much as in the winter when you have only 35 degree water in the mains.

We are going to make the tests as often as we can by using a larger scale on the meter and using it later in the fall when the water has dropped in temperature and the thermostat is closed. Theoretically, there will be some drop due to distribution losses and we hope to get the figures later on in the year.

*Mr. E. V. Buchanan, London (by letter):*—We believe that water heater control equipment can be justified on the basis of other equipment saved, such as transformers, cables and other parts of the distribution system. The per kilowatt cost of the water heater control apparatus is less than half the cost of the alternative load carrying equipment and, where loads are growing, requiring that a choice be made, it is likely that the answer must ultimately be in favour of the control apparatus.

* * * *

3. What are the economics of installing 1,500 watt thermostatically controlled booster units in connection with flat-rate water-heaters insofar as the utility's cost of power is concerned?

*Mr. J. W. Peart, St. Thomas:*—I think this question might be better worded by simply asking if our booster heaters on flat-rate water-heater installations are a desirable load from the standpoint of the utility. I don't intend to attempt to answer that fully, as I think we are

all guided by our experience in our different municipalities.

We must remember that the business of heating water is one of a very few instances where an electrical utility can store up energy. Therefore I would suggest that the most ideal installation would be one where adequate tank storage capacity is provided, so that the flat-rate unit may be made to carry the burden one hundred percent of the time.

We know that there are cases where the maximum demand for hot water is in excess of the capacity of the flat-rate heater and in these instances you can solve the problem by the use of boosters.

We started out six years ago in the water-heater campaign. When it was launched we didn't know very much about the business. We focussed our attention upon the size of the heater more than upon the size of the tank, and at the end of a couple of years we had about 600 installations and 170 of these were equipped with boosters. When we got our feet on the ground we started out with graphic meters to find out something of the operation of the booster. These, of course, were installed with thermostats and the theory was that the booster would come on automatically at times that the tank was running short of hot water.

We discovered on investigation that the housewife got on to the fact that we had a second switch on the service box and she got the habit of pulling the switch on the booster. In fact, we discovered that very few of these boosters were operating automatically. We traced this through further and we found that booster heaters were used principally on the proverbial wash-day, when by probably ten, or ten-thirty, the supply of hot water in the tank was pretty well depleted. At that time she would walk over and close the switch on the booster heater. The result was that it was left on until probably one or one-thirty in the afternoon, and of course created a demand of 2 horsepower during our system peak, which invariably occurs ten months of the year, between eleven-thirty and twelve o'clock noon.

We had separate kilowatt-hour meters on these booster heaters and we found that in a period of thirty days we got probably 20 to 30 kilowatt-hours consumption out of each of them.

I will admit we very seldom pay for a monthly peak occurring on a Monday, the proverbial washday I refer to, but there is so little difference between the Monday peak and the Tuesday peak, which is the one we are in the habit of establishing as the result of ironing day, we have anticipated that if the use of boosters became prevalent we would eventually be buying a considerable amount of current to meet the booster demands on Monday, and from our point of view we couldn't altogether reconcile the cost of 2 horsepower in relation to the relatively small kilowatt-hour use we would collect for.

Consequently, we tackled the problem with the view of talking up larger tanks. The result is that to-day we have 1,160 water heaters on the system, and we have reduced the number of booster heaters from 170 to 158. In St. Thomas we are dealing with a

water supply much the same as Mr. Dobbin referred to, where the minimum temperature in the winter months is around 38 degrees, and the maximum in the summer months is close to 70 degrees, and we are getting by very nicely. I suggest that we should strive toward the ideal, which is make the flat-rate unit carry the load. I know that where the booster heater is allowed to float automatically on the line, sufficient revenue will be obtained to off-set the cost of power.

I quite appreciate that other systems may not have peaks occurring from eleven-thirty to twelve o'clock noon. They may have evening peaks, and in those cases they will have an entirely different answer to this question. However, that is how we find it in St. Thomas.

*Mr. O. C. Thal, Kitchener:*—In answering this question, I would like to state at the outset that it is difficult to determine the current consumption of booster heaters unless meters are set on all such circuits. However, we have set out certain figures which have been arrived at by less elaborate means which may give us a picture, perhaps fair enough for the purpose intended, of the cost of power and the revenue which may be derived from booster heaters.

*Power Cost*—A check up of several hundred booster installations indicated that, with the exception of Monday (washday), approximately 2 percent were on at time of peak load. As our peak load has never occurred on a Monday, this load would account for approximately 27 h.p. of our power account at a cost of $52.88 per month.

*Revenue*—The approximate revenue was arrived at by picking at random a group of consumers who have had boosters installed a year or more after the flat rate heaters had been installed. These showed an average increase of 74 kw-hr. per month for the year, during which the booster was installed, against a similar period prior to the booster installation. As part of this increase may come from sources other than boosters, the consumption of another group of consumers, taken at random, who are not using flat rate water heaters was checked. This check indicated an average increase of 19 kw-hr. per month for similar periods. Deducting this amount, we find a difference of 55 kw-hr. which may, perhaps, be properly credited to booster use. If this, then, could be taken as an arbitrary figure to use for all boosters, the 686 boosters we have in use in Kitchener should consume 37,730 kw-hr. per month, representing a revenue at the second domestic rate of $301.84. However, investigation has revealed that close to 50 per cent of booster users turn the booster switch off and on as they believe it necessary. This manual operation of boosters results, of course, in decreased revenue from that set out above of an amount that is very difficult to determine even approximately.

In this connection it might be well to consider the use of switch boxes, the flat rate switch and the booster switch of which are operated together by a single lever on the outside of the box. By this means, the booster unit would be entirely controlled by its thermostat. An undoubted in-

crease in revenue from 50 percent of our booster users would result, together with more satisfactory service to them.

It would appear, from the above, that if all boosters were thermostatically controlled only, a revenue more than sufficient to pay all costs properly chargeable to boosters would be obtained in Kitchener.

* * * *

4. What charges, if any, are made to a prospective customer in remote districts not already served by power lines?

Discussion of Question No. 4 showed that there is no set standard among the utilities for such cases. Some required deposits, others guarantees while again others gave service requiring no additional monetary consideration using standard rates.—EDITOR.

* * * *

5. Should the 75 per cent. Clause on reduced demands for power billing be reduced to 50 per cent.?

*Mr. J. E. B. Phelps, Sarnia:*—I think we all agree, at the inception of Hydro in all the municipalities, with from ninety to ninety-five—practically a hundred percent—in debt, loaded up with fixed charges on debentures, et cetera, there was some reason for this penalty clause, as you might call it, the 75 percent clause in billing. If the customer got below 75 percent he was charged with 75 percent.

Over a period of years Hydro has been going on in this province—25 or 26 years or longer—and the time has come when we can eliminate at least part of that penalty. It does not bring in an awful lot of revenue as far as the municipalities are concerned, but it is a very contentious point.

I think you will all agree with me the average power user doesn't mind paying for what he thinks he gets, but he is not going to pay for something he knows he doesn't get.

I took the trouble to take the 1937 report and figure out the expense of operation, or the percentage of cost, as compared to the plant value. I took five cities in this province and they vary from 30 to 46 percent, so apparently the time has arrived when we can reduce this cost from 75 to 50 percent and still remain solvent, and possibly get away from a whole lot of criticism in explaining over the counter to our consumers.

I would like to suggest that this Question Number 5 be referred to the Rates Committee for further discussion in that Committee, with the view, if they find it is reasonable, that they pass along a recommendation to the proper authorities to see if we can not get this reduced from 75 to 50 per cent. I am in favour of reducing it.

*Mr. W. R. Catton, Brantford (by letter):*—In good times the clause is seldom used. In depression times when our manufacturers are hard pressed it appears as though the reduced charge would be quite welcome. Where a consumer does not ride the system peak because of shut down, surely 50 percent will cover our capital cost to serve, especially if that consumer purchases primary power. If the customer is small, he may be

served from a bank with other power users who will take care of fixed charges.

* * * *

6. To make Commercal Lighting Load Building easier, can the rate be arranged to act less as a deterrent to additions?

*Mr. R. T. Jeffery, H.E.P.C. of Ontario, Toronto:*—All of the rates which we use were primarily, and, I believe are still, intended to be such that each consumer shall pay as near cost of the service as possible.

The other day I saw a short article in a Toronto paper, stating that a delegation of gas users, in Toronto, had approached the City Council with a petition requesting that the 50-cent service charge on gas in Toronto be removed entirely from the rates of the Gas Company.

There are three classes of people who consider the matter of service charge. One class is those who can and do think. Another is those who do not think, and the third is those who won't think. Now, I ask you to think just for a minute. The gas consumers and the electric consumers are exactly similar in regard to the matter of service charge as part of the rate structure. In the case of the gas consumers; the gas pipe and gas meter are installed and a gas supply is all ready at the consumer's premises to supply the consumer whenever he wishes to use the gas and the service charge is intended to cover the cost of this readiness to serve the consumer by the Gas Company. This delegation was apparently composed of one or other of the last two classes and expected the Gas Company to go to the expense of installing a service and a meter ready to supply them with gas at any time whether they use the gas or not. I suppose they expected that other consumers could pay the carrying charges on such a service, if no gas was used.

"Hydro" is in the same position as the Gas Company. Hydro installs the service, the transformer and the meter ready to supply current to the consumer, and if the consumer does not pay the carrying charges on this equipment, other electric consumers must pay these charges. Now, is Hydro going to be a philanthropist and supply service free, or is Hydro going to charge some of the consumers for service to other consumers who do not want to pay?

Hydro rates are based on the principle that each consumer pays as nearly "cost" as possible for the service rendered.

I do not say that the service charge on commercial service should not be removed. The service charge has been removed pretty much from domestic lighting service gradually throughout the Province. There are a few municipalities that still have a service charge in their domestic lighting rates and one or two of them have the old service charge calculated on a floor area basis, and a few are still left who have the 33-cent and 66-cent service charge, but this service charge will be removed, I believe, just as soon as a rate reduction is made in these municipalities, which will warrant cutting out the service charge without thereby increasing some of the domestic consumers' bills; for, when

you cut out the service charge, and at the same time do not reduce your domestic revenue by making a rate reduction, some of the domestic consumers are bound to pay more money for the service they receive. In other words, unless the rate reduction is made at the time the service charge is cut out, the revenue that was formerly obtained as a service charge must be transferred to the first kilowatt-hour rate.

As regards the commercial lighting rate, the service charge could be discontinued, I suppose, and the revenue now obtained from service charge transferred to the first kilowatt-hour rate, but that would mean that those consumers who did not use very much energy would have their service charge transferred to the consumers who do use energy.

There is also another point to keep in mind that the large commercial consumer in character approaches very much the condition of the small power user, and, in fixing the rates in any municipality for power and commercial lighting, we try to keep the commercial lighting rate and the power rate so that there is very little difference in the cost of service for the same demand and the same number of kilowatt-hours used.

The matter of service charge for commercial lighting is one, I think, that will evolve through time and solve itself, and your Rates Committee, which is very competent and is composed of some of the best brains in your organization, will discuss this matter, and I am sure will give you an answer that will be satisfactory to you and to all concerned.

7. What experience are municipalities having with Bell Telephone-Hydro Joint Agreements?

*Mr. O. M. Perry:*—The Hydro Division in Windsor and representatives from the Bell Telephone Company have discussed this proposed agreement a number of times during the past few years. Nothing definite was accomplished until at the last meeting on June 13th the major differences were settled.

The chief difficulty was arriving at what the height of the standard joint pole should be. We had decided on a 40 ft. pole as our requirement, and after some delay the Bell Telephone Co. finally agreed to this size of standard pole for Windsor.

The reason for deciding upon a 40 ft. standard pole, is to have sufficient space in order to hang transformers. Even with a 40 ft. pole and the transformer hung above the B.T. cable, the bottom of the transformer will be in the majority of installations, at a maximum distance above ground level.

Some blocks in residential districts may have two transformers connected for 115 volts at each end of the block. With one transformer per pole, there would be therefore 4 transformer poles in the block. To have a uniform line it is necessary to have 40 ft. poles.

Any variation in the above standard pole may be taken care of on the permit as shown in Exhibit C which will be issued for each particular joint line.

The 35 ft. pole would be satisfactory to the B.T. Co. but usually the

extra height is required by the power company and it is to the advantage of the latter that the standard pole chosen is not too short.

Some of the plates in the standard agreement, show street lighting brackets below the telephone equipment. In Windsor our lowest light centre on any wooden pole is now 21 feet. With this and higher light centres, the street lighting equipment will be above the Bell Telephone. In Windsor we are using a lighting bracket with an upward bend. With a bracket of this type a gain is made in light centre.

The agreement provides for the use of pole steps above the 8 foot level on transformer poles. One solution for this question might be to eliminate all permanent pole steps on transformer poles and substitute detachable pole steps.

In the choice of poles for street construction, the utilities should specify western cedar poles, which should be properly shaved and stained or painted. With street construction, street lighting will probably be attached and the question of the appearance of the joint line is very important.

*Mr. E. V. Buchanan, (by letter):*—London has for years placed overhead lines on poles jointly owned with The Bell Telephone Company of Canada. Results have been very satisfactory, only minor difficulties have arisen and the improvement in the appearance of the streets has been very marked. The arrangement has also permitted this Commission to change from poles which had completed their useful life to new poles at a minimum cost.

8. What do municipalities think of Bell Telephone construction of joint leads?

*Mr. R. S. Reynolds, Chatham:*—I believe the questions 7 and 8 should have been joined together as I think question No. 8 is rather ambiguous. I didn't know whether it meant the actual construction of the lines themselves or whether it meant the negotiations for same with the Bell on the construction of joint leads.

I think Mr. Perry covered both these questions very well as regards his municipality and I am at a loss to tell what other municipalities think of this agreement, although I can give you our experience and tell you what we do in the city of Chatham.

We have had a very good experience with the Bell Telephone, both in the negotiations and construction under this agreement. There have been differences but they have been satisfactorily ironed out and the basis of the joint agreement has been approved by my commission.

The construction of the joint leads has been changed in some ways from the standard and I guess that Chatham is in the same position as other municipalities in that you have to take conditions governing actual construction as you find them and adapt your lines to these conditions.

On the main thoroughfares where you can get reasonably clear lines, I believe that the minimum height of joint poles should be 40 feet over all, especially if there happen to be low buildings, which have to be served on the other side of the street. This height allows very good clearance be-

tween the companies and also gives some room for rebuilding.

I might also add that in the moving of buildings, of which we have had a lot in recent years, that main thoroughfares are used wherever possible and it has been unnecessary to raise our wires where they have a reasonable clearance at the present time, such as on this type of joint lead.

On other thoroughfares throughout the city we have, in the main, a very large number of trees and when constructing joint leads you have to consider the property owners. Sometimes when you mention cutting limbs off a tree for proper clearances, you take your life in your hands, so you have to be guided by these conditions in determining the proper height of poles and other construction points.

There are minor points such as the street lights on poles and the drop wires to series street lights to be considered and I may say that in Chatham, in the majority of joint leads, we have raised the light bracket to 21 feet from the ground, which gets above the Bell Telephone cable for the series street lighting. We do not like the heavy cable in the series street lighting drop running around the pole and getting in everybody's way who may be called upon to work on that pole.

It is the same way in respect to pole steps. I think it is an acknowledged fact that we cannot keep boys off the poles if the steps are within reach of them. They get playing around and they go as high as they can on the steps and slide down the guy wires and do everything else that they should not. We have tried to install detachable steps below a point eight feet from the ground.

In the general construction of the leads themselves we have been able to arrive at a very satisfactory basis with the Bell Telephone. I do say that the cost in some cases is more than if we were on separate poles but I believe that the construction is also better.

*Mr. R. H. Hatcher, Galt:* I think Questions Nos. 7 and 8, like Mr. Reynolds has intimated, should be answered together, and I think both Mr. Perry and Mr. Reynolds have given us about all the information there is. It is evident that a great many are thinking alike on this question. That is all I have.

* * * *

9. What schedule should be used in the interests of distribution transformer maintenance?

*Mr. P. B. Yates, St. Catharines (by letter):*—In answering this question, two other questions occur to me. The first one is: Why should I be asked this question when my experience with distribution transformers began in 1914 and there are so many of you operating transformers that were installed in 1910?

The second question which occurs to me is to inquire the reason for the question. Our distribution transformer maintenance costs are lower now than they were during the war years, when our transformer capacity to be maintained was ⅓ of that which we have at the present time. Is it that some of you who have been oper-

ating 25 cycle equipment since 1910 have begun to feel an increase in your maintenance costs?

As a direct answer to the question I can say that we check the oil in our distribution transformers each fall before the winter loads come on. We use paint when necessary to improve appearances. We maintain a close watch on secondary loads, but the interests of distribution transformer maintenance are but secondary in our reasons for doing this work.

This is a question that, as far as I can remember, has never been discussed at any convention of this Association. Possibly there has been no occasion for serious consideration of this question to date, but for the three reasons of service, efficiency and economy, the consideration of this question as applied to the transformers purchased during the period from 1910 to 1920 should warrant a report from the Research Department of the Provincial Commission, and I would, therefore, suggest that the Association ask the engineers of the Commission to prepare a paper on this subject for presentation at the next Winter convention.

*Mr. V. A. McKillop, London (by letter):*—Transformers are tested for load at least once each year with a clip-on ammeter. This is done in the fall around 6 p.m. and may be repeated once or twice, if there is any indication that the readings taken are not the maximum. Lightning arresters, cut-outs and fuses are examined for loose connections, etc. Oil is tested and filtered as required. Terminals are cleaned and new primary and secondary leads are installed in some cases. Transformer cases are grounded.

No actual schedule is adhered to in making these inspections but these items are under more or less constant observation.

* * * *

10. Should voltage on street lamps be cut after midnight in an effort to lower the cost of lamp replacements?

*Mr. D. E. Charters, Windsor:*—My answer is "no".

Unfortunately, the question does not state whether series or multiple lamps or both were implied. The series has a normal life of twice the multiple lamp or even more and again the series lamp costs approximately three times a multiple lamp. The series lamps retain their efficiency throughout their life while multiple lamps lose their efficiency and at normal life depending on size of lamp may be from 70 to 85 percent efficient. Lamps have become much cheaper in the past few years and after all lamp costs are a very small percentage of total street lighting costs.

We have many other factors to consider but in multiple lamps a 10 percent over voltage reduces lamp life to nearly 30 percent life. A 10 percent under voltage increases lamp life to nearly 300 percent life. With 10 percent over voltage we obtain 137 percent light and with 10 percent under voltage we obtain only 70 percent light.

If multiple lamps are to be considered and we will assume the municipality has a regulation where the night voltage is above normal and day

voltage is normal or slightly less and unless the voltage is regulated in some way then this night voltage effects not only the multiple street lighting but also the home, stores, signs, factories, etc., within the limits of the distribution of this municipality and in fairness to all regulation should apply beyond the street lights only. My reason for mentioning this voltage condition at night is because this is so often the case where the late night voltages are above normal and the life of lamp is reduced unnecessarily, and this being the case, voltage on street lights should be controlled before and after midnight to keep normal voltage at each lamp socket.

Where municipalities have this condition and have no control over voltage they could use a 5 or 10 percent over voltage rated lamp and obtain a little less light and increase lamp life depending on voltage conditions.

Most accidents occur between darkness and midnight and controlled voltage to give our streets the best lighting at this period is most important and to give extra light after midnight and thus shorten the life of lamps is not necessary and in my opinion controlled normal voltage at all times of the day would not only take care of street lighting, but this same regulating equipment would give to other users of home, stores, signs and factories better lighting conditions.

Not one of the streets in Windsor is over lighted and our aim is to give the best lighting at all times. Many through highways pass through the main streets of so many of our cities, towns and villages that good lighting after midnight is very essential.

* * * *

11. What allowance for depreciation on old poles should be credited to motorists who break them?

*Mr. A. B. Manson, Stratford:*—Inasmuch as the Chairman is associated with me in answer to this question I will deal with Western Ontario only, leaving practices in Eastern Ontario to Mr. Chase.

I have attempted to gather information from a number of municipalities and find replies which are extremely varied. In general though it is apparent that no set practice is followed. Some municipalities charge for a new pole without regard to its spent life. This in my opinion is rather questionable practice. I am doubtful if it could be established in law.

Some cities seemingly are not greatly interested inasmuch as they rarely catch up with the motorist causing the damage. That I imagine is rather interesting information.

However, the consensus of opinion seems to be that the motorist should be allowed the depreciated value of the broken pole. Each individual case is to be considered on its merits when it comes up and the estimated probable further length of life of the pole used as a basis of charge.

That is the method followed in Stratford. I believe it is equitable, I believe it is just and I think it is probably the proper and legal method to follow in justice to the offending motorist and the paying public. The question is open for discussion.

*Mr. G. E. Chase, Bowmanville (by letter):*—My answer to Question No. 11 is that we do allow depreciation, but have no set percentage. We take each case on its own merits. However, I am of the opinion that a uniform rate of percentage should be set that would be applied to the whole province, as I firmly believe that a motorist is entitled to be credited with depreciation. I think it would be a move in the right direction to appoint a committee from our association to study this matter and bring in a report with a view of getting some standard that all municipalities could apply.

* * * *

12. Do you connect together the secondaries from say seven or eight transformers and if so, do you use secondary fuses?

*Mr. C. H. Hutton, Hamilton:*—In Hamilton we do not at present and I don't see how it is possible on three-phase distribution to connect together seven or eight transformers unless you forego some of the advantages of three-phase transmission. Obviously, it must be done in one-phase groups. Some thirty years ago on 66 cycle, 2 phase distribution in Hamilton transformers were banked and we did not use fuses on the secondaries. The answer in Hamilton is "No" at present.

*Mr. R. S. Reynolds:*—The only answer I can give is "No."

* * * *

13. Do you control voltage in any way?

*Mr. D. E. Charters:*—Yes, we control voltage. In the first place we receive our power from the H.E.P.C. at 26,400 volts and all our substation transformers have four 2½ percent reduced voltage taps. By use of these taps we control our substation voltages. May we mention here our substations are located near centre of loads and in most parts are about two miles apart.

Our average length of 4,000 volt primary feeder is about one mile long and 1½ miles is limit length of any feeder. The branch feeder may feed ½ mile and in some cases more from the main feeder.

We have some 4,000 volt feeders feeding large power loads unregulated and nearly all other feeders are equipped with 3 phase mostly 100 kv-a. induction regulators 4,000 volt with 5 or 10 percent boost or buck. The longer feeders are connected 10 percent. All of our induction regulators are of the indoor type oil insulated.

We take weekly graphic voltage charts from each circuit from the district and voltmeter is located about ⅓ distance from load centre. Each voltmeter is a one day seven day meter and operator obtains daily chart when necessary to change "R or X" of regulating equipment.

As we are located at end of a long 110 kv. line these induction regulators do double duty of holding up the voltage in day and holding down the voltage at night and for most part keeps voltage within very close limits.

* * * *

14. What spare capacity do you consider necessary, particularly in substation transformers?

*Mr. R. B. Chandler, Port Arthur:*—In discussing this question we are eliminating any reference to the required surplus for load growth. This factor will vary, depending on local conditions and a study of the load curve for any previous period will enable a fairly accurate estimate for future requirements.

Provision for failure of a single unit in any transformer bank, to insure continuity of service should be arranged. This, I am presuming, is what is implied by the term "spare capacity".

In wye-delta banks, using single-phase transformers, a spare unit should be provided to maintain full capacity in the event of a single transformer failure. The use of this type is not recommended and they should be replaced where economic factors will permit.

In delta-delta banks, the total connected load should not exceed 80 to 85 percent of the full rating to enable carrying full load when operated in open delta.

The standardization of transformer connections is essential for various stations to permit the transferring of loads between stations without interruption of service. This operating feature can readily be provided by the use of the lines between stations so that the surplus load from station where failure occurs can be picked up elsewhere.

*Mr. C. C. Folger, Kingston (by letter):*—In my opinion it depends a great deal on the type of substation and area, and whether or not one is considering rural or urban distribution.

On an installation of three, single phase transformers, I would consider that one-third of the station capacity should be sufficient spare capacity.

On a three phase, self-contained installation, covering loads of 2,000 h.p. and over, the consumers should be guaranteed fifty per cent of that station's peak load.

* * * *

15. What kind of service do you consider the most satisfactory, open wire, or cable; if cable, what type?

*Mr. W. E. Reesor, Lindsay (by letter):*—My experience would lead me to favor open wire for services in almost every case. There is an occasional place where cable is preferable. My impression is that where cable is used it should be kept clear of trees or any object that could cause any abrasion of the insulation. Before cable is used generally it should be improved so that the insulation is more rugged than at present and it should not be made any heavier, otherwise the sag is too great.

* * * *

16. Do you consider the possibility of underground service cable coming into general use to be a factor in the consideration of outdoor metering?

*Mr. C. H. Hutton, Hamilton (by letter):*—Not a serious factor for residences. In such instances "New Sequence Plug-In Meters" could be placed in a conduit loop outside the residence or in the basement. Any additional expense above the cost of the standard "free" municipal service run should be then charged to the consumers on the special underground service put in at his request.

*Mr. A. E. Ditchburn, Strathroy (by letter):*—I doubt that the use of underground service cable will become general, however, I feel that the use of underground service cable has no particular bearing on the use of detachable outdoor or indoor watthour meters.

In the case of extending the cable to an outdoor meter, mechanical protection will be required for the exposed portions of the circuit. The remainder of the circuit will be completed in the usual manner.

* * * *

17. Uniform Hydro accounting practice provides that a maximum of 30 per cent. of the total Plant Value should be established as a Depreciation Reserve; is this figure too high or too low when experience indicates that Obsolescence is a more important factor to provide for than ordinary wear and tear?

*Mr. P. B. Yates (by letter):*—Our present consumers are paying interest on the money that we borrowed to build our plant; they are paying sinking fund or principal payments to retire this debt; they are also paying as operating charges for the maintenance of this plant in a satisfactory operating condition. We are also using the surplus earnings from our existing system to extend the system without the issue of debentures; and then, to top it all, we plan to hand over to our children, a system in perfect operating condition, not only free of debt, but also hand over to them a reserve equivalent to 30 percent of the cost of the system.

Each year in our operating report, we charge ourselves 4 percent for the use of the funds in the depreciation reserve which may be invested in extension of system. This is charged at 4 percent despite the fact that any solvent municipality at the present time can borrow money at less than this rate.

I claim that no accountant can demonstrate to an engineering body that under our system of financing and maintaining our systems, that any reserve for depreciation in excess of a small percentage is at all necessary. We should have a reserve only sufficient to equalize our annual rebuilding or replacement costs. Ten percent of the plant cost should be ample.

I have omitted consideration of obsolescence—so did the committee thirty years ago when they drafted the accounting system. My reason for this is that the retirement and replacement of equipment due to obsolescence as distinguished from ordinary wear and tear and depreciation, can be spread over a term of years as surplus funds become available. Replacing a transformer because the saving in core loss may make the expenditure a good investment, or replacing a meter because the increased efficiency of registration may also make it a good investment, may both be postponed until such a time as the surplus funds for such investment are available.

Under the present regulation the operating charge of interest on the depreciation reserve greatly exceeds the annual charges to that reserve. Why continue to magnify this reserve?

In conclusion, I suggest that those of us who were concerned in the original foundations on which Hydro systems are based, wished to emphasize to the enemies of municipal ownership that our municipal systems were financially sound, and more than sound—we leaned over backward.

Finally, may I suggest that this question be referred to a committee from the accounting and engineering departments of the Commission, together with some managers of municipal systems.

*Mr. R. M. Bond, H.E.P.C. of Ontario, Toronto:*—The Hydro-Electric Power Commission of Ontario authorizes the depreciation rate as applying to municipal electric utilities operating under contract with them. This rate applies to all tangible plant with the exception of automobiles, trucks, office equipment and tools which have a comparatively short life and are therefore written off at an accelerated rate. The depreciation of buildings is also treated differently as it is recognized that they are not subject to wear and tear to the same degree as other tangible plant.

With the above exceptions the rate on "Tangible Plant" was 3½ percent per annum in cities and 4 percent per annum in towns and villages, plus an improvement of 5 percent per annum on the balance in the depreciation reserve account and applied to all contracting municipalities except Toronto where a rate of 3¼ percent per annum, plus improvement was authorized. This condition prevailed until 1922.

In 1922 the matter was given further study and the H.E.P.C. authorized a change in rate as follows:—

> One and one-half percent per annum on depreciable plant, plus an improvement of 4 percent per annum in Toronto and Hamilton.
>
> Two percent per annum, plus an improvement of 4 percent per annum in all other municipalities.

A maximum reserve of 30 percent of the total depreciable plant was set. This maximum was to apply only if the distribution system was kept up to 70 percent efficiency. The maximum will therefore prevail only in municipalities that have accumulated a depreciation reserve amounting to 30 percent of the tangible plant, provided assurance is given by the Municipal Department that the distribution system is up to the required efficiency.

Uniform Accounting practice does not recognize obsolescence as other than a factor of depreciation. Depreciation is defined in the report of the Special Committee on Depreciation of the National Association of Railroad and Utility Commissioners, submitted November 15, 1938, as follows:—

> "Depreciation as applied to depreciable utility plant means the loss in service value not restored by current maintenance, incurred in connection with the consumption or prospective retirement of utility plant in the course of service from causes which are known to be in current operation and against which the utility is not protected by insurance. Among the causes to be given consideration are wear and tear, decay, action of the elements, inadequacy, obsolescence, changes in the art, changes in demand and

requirements of public authorities and in some cases the exhaustion of natural resources."

Therefore until such time as due consideration has been given the question of obsolescence the authorized rate must stand.

* * * *

18. What percentage of the total Depreciation Reserve should be considered as that portion covering Obsolescence?

*Mr. R. M. Bond:*—The Municipal Accounting department has no data available in this matter as we have always considered that obsolescence was merely a contributing factor in the whole question of depreciation and have not thought it necessary to place any undue emphasis on it.

## The Simple Life of the Executive

In an article in *Advertising Age,* Mr. F. C. Bierne said that executives really had nothing to do, except:

To decide what is to be done; to tell somebody to do it; to listen to reasons why it should not be done, why it should be done by somebody else, or why it should be done in a different way, and to prepare arguments in rebuttal that shall be convincing and conclusive . . .

To follow up to see if the thing has been done; to discover that it has not been done; to inquire why it has not been done; to listen to excuses from the person who should have done it and did not do it . . .

To follow up a second time to see if the thing has been done; to discover that it has been done but done incorrectly; to point out how it should have been done; to conclude that as long as it has been done, it may as well be left as it is; to wonder if it is not time to get rid of a person who cannot do a thing correctly; to reflect that the person at fault has a wife and seven children, and that certainly no other executive in the world would put up with him for a moment; and that, in all probability, any successor would be just as bad or worse . . .

To consider how much simpler and better the thing would have been done had he done it himself in the first place; to reflect sadly that if he had done it himself he would have been able to do it right in twenty minutes, but that as things turned out he himself spent two days trying to find out why it was that it had taken somebody else three weeks to do it wrong; but to realize that such an idea would strike at the very foundation of the belief of all employees that an executive has nothing to do.—*Electrical Digest.*

# THE BULLETIN

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# The Exhibition Display of The Hydro-Electric Power Commission of Ontario

ONE of the outstanding features in the Electrical and Engineering Building of The Canadian National Exhibition of 1939 was the display of The Hydro-Electric Power Commission of Ontario, produced under the direction and supervision of the Sales Promotion Department.

The display occupied a central position in the building and presented in its simple modern streamlining a spectacle of beauty having as its theme the development of power from water. It consisted of a main central unit flanked, on each side, by a complementary unit, the whole occupying a floor space sixty feet by forty feet. The finish was dull white which together with the park-like setting of turf and evergreens formed a striking effect. The setting was designed and executed by the Niagara Falls Park Commission.

The central unit consisted of a waterfall 14 ft. high and 10 ft. wide out of the base of which arose five white horses typifying the power available from waterfalls. The water was flood-lighted and a spotlight of changing colours played on the horses producing a very pleasing effect. The lighting was particularly effective at night, but during the day the brilliant light from the sky-lights of the building tended somewhat to lessen the striking nature of the lighting scheme.

The water coming over the falls collected in a tank at the base to be recirculated to another tank at the top by an electrically driven pump discharging 285 gallons per minute.

It was interesting to note the curiosity of the observers whose first impression seemed to be that the falling water was an illusion produced by lighting or movies and only on very close inspection were they convinced the water was real.

Incorporated in the sides of the central structure, three on each side,

## CONTENTS

**Vol. XXVI No. 9**
**September, 1939**



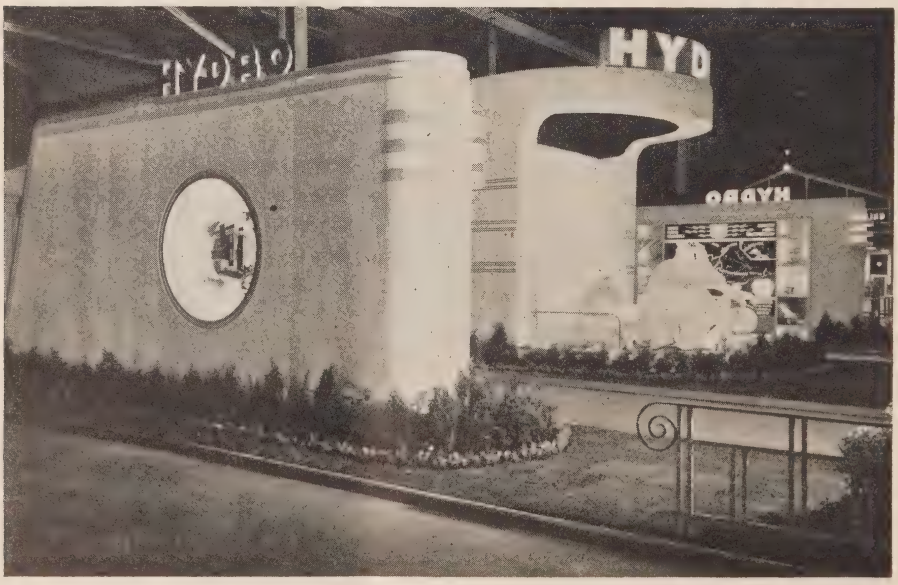
*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

were illuminated enlargements of six typical power developments, the most outstanding of which from the artistic standpoint appeared to be an aerial view of the plant at Cameron Falls on the Nipigon river.

On the inner face of one of the side structures was mounted a large transparent glass map of the province of Ontario, showing the power plant locations, transmission lines, distribution sub-stations and the chief branch lines therefrom as at 1939.

The map was in colour and lighted from the rear in such a way as to show up first the Niagara system, then in rotation the Eastern Ontario system, the Georgian Bay system and the Northern Ontario system, following which the whole map lit up; and then the cycle repeated.

At the bottom of the map an illuminated graph showed the average cost of domestic power in Ontario an-




*Hydro display at Canadian National Exhibition.*


*Left side display illustrating average cost of operation of domestic appliances.*

nually from 1914 to 1939, and another graph showed the average monthly domestic consumption in kw-hr. for the same periods.

At each of the four corners of the large map smaller illuminated maps illustrated the transmission lines in existence as at 1910, 1920, 1930 and 1939 respectively.

Flanking the large map were illuminated coloured transparencies showing the main features in the generating and distributing system, viz.: generation, control panels, transmission tower and lines, transformer station, pole transformers, and street lighting application.

The theme of this panel was wide distribution, economy, and reduction of rates on increase of consumption.

On the inner face of the other side structure a series of illuminated transparent photos of electrical equipment used in the home were arranged around a central motif, a bronzed replica of *one cent.* Opposite the view of each appliance a legend showed the number of hours use of the appliance that could be obtained for a current cost of one cent, the calculations being based on a rate of one cent per kw-hr.

The exhibit was manned from the staff of the Sales Promotion Department, two men being on duty at all times from the opening hour in the morning until the closing hour at night. Their duties were to supervise the display and supply information to interested spectators.

Exhibition visitors spent much time at the display and passed many complimentary remarks on it.

# The Use of Electricity Grows Steadily

## Consumption and Revenue—Hydro Domestic and Commercial Compared With Former Years

THE use of electricity by domestic and commercial consumers during the year 1938 showed a very substantial increase over the previous year and revenue was well maintained. This increase in kilowatt-hours consumed is almost entirely due to the greater use of electrical appliances by existing consumers.

In the tables of revenue and consumption which follow it is evident that the Commission's activities have influenced the rate of use by all classes of consumers. The Commission's activity in promoting electric cooking, water heating and better lighting is shown by the increased consumption this year.

The following tables show the growth in consumption and revenue and in the number of consumers served from year to year since 1913, and are divided into the two classes of domestic and commercial service, with each class into cities with a population of 10,000 or more, towns with a population of over 2,000, and villages with a population under 2,000. Each table shows the annual revenue, annual consumption, number of consumers, the average cost per kilowatt-hour, the average monthly bill and the average monthly consumption.

### DOMESTIC SERVICE

Table No. I shows that the domestic consumers in cities have continued to increase their kilowatt-hour consumption. The reduction in rates from year to year is shown by the slight reduction in total revenue. The effect of this is to reduce the average cost per kilowatt-hour to 1.19 cents,

## TABLE NO. I

### DATA FOR CITIES OVER 10,000 POPULATION

### DOMESTIC SERVICE

| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Consumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 12 | $ 614,925.00 | 12,646,400 | 55,597 | 4.86¢ | $1.06 | 21.8 |
| 1917 | 19 | 1,063,264.00 | 36,693,100 | 107,248 | 2.89 | .88 | 30.5 |
| 1920 | 21 | 1,926,924.00 | 84,328,000 | 154,186 | 2.29 | 1.11 | 48.4 |
| 1923 | 21 | 3,772,416.00 | 206,266,200 | 223,028 | 1.83 | 1.53 | 83.5 |
| 1927 | 24 | 6,086,753.11 | 371,945,485 | 276,632 | 1.63 | 1.87 | 114.4 |
| 1930 | 26 | 7,921,316.00 | 541,876,998 | 315,611 | 1.46 | 2.11 | 144.4 |
| 1933 | 26 | 8,495,321.93 | 595,211,863 | 330,597 | 1.43 | 2.14 | 150.0 |
| 1936 | 26 | 9,743,001.62 | 720,002,863 | 350,083 | 1.35 | 2.32 | 171.4 |
| 1937 | 26 | 9,557,649.65 | 752,498,158 | 353,826 | 1.27 | 2.25 | 177.2 |
| 1938 | 26 | 9,426,825.47 | 792,450,767 | 361,669 | 1.19 | 2.17 | 182.6 |

## TABLE NO. II

### DATA FOR TOWNS OVER 2,000 POPULATION

### DOMESTIC SERVICE

| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Consumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 19 | $ 90,330.00 | 1,414,500 | 7,410 | 6.38¢ | $1.11 | 17.4 |
| 1917 | 27 | 180,075.00 | 3,824,600 | 15,731 | 4.71 | 1.01 | 21.4 |
| 1920 | 36 | 353,915.00 | 10,053,100 | 24,041 | 3.50 | 1.26 | 36.0 |
| 1923 | 43 | 651,499.00 | 25,411,300 | 34,135 | 2.56 | 1.57 | 60.1 |
| 1927 | 55 | 1,325,096.89 | 62,105,723 | 56,813 | 2.13 | 1.99 | 92.9 |
| 1930 | 53 | 1,468,194.00 | 73,234,125 | 58,490 | 2.01 | 2.10 | 105.0 |
| 1933 | 60 | 1,584,772.57 | 82,321,996 | 63,910 | 1.92 | 2.07 | 107.3 |
| 1936 | 57 | 1,460,916.64 | 80,678,385 | 61,102 | 1.81 | 1.99 | 110.1 |
| 1937 | 58 | 1,428,387.72 | 86,912,430 | 63,067 | 1.64 | 1.89 | 114.8 |
| 1938 | 60 | 1,689,908.10 | 113,673,154 | 68,894 | 1.49 | 2.04 | 137.5 |

## TABLE NO. III

### DATA FOR VILLAGES UNDER 2,000 POPULATION

### DOMESTIC SERVICE

| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Consumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 18 | $ 24,913.00 | 291,000 | 1,859 | 8.55¢ | $1.10 | 13.1 |
| 1917 | 77 | 97,516.00 | 1,412,500 | 8,334 | 6.90 | .96 | 14.0 |
| 1920 | 109 | 233,819.00 | 3,829,900 | 15,665 | 6.00 | 1.29 | 21.2 |
| 1923 | 142 | 531,505.00 | 11,249,100 | 29,689 | 4.72 | 1.59 | 33.7 |
| 1927 | 188 | 1,095,340.79 | 35,900,482 | 52,088 | 3.05 | 1.81 | 59.5 |
| 1930 | 194 | 1,363,210.00 | 55,917,187 | 59,159 | 2.43 | 1.95 | 80.1 |
| 1933 | 214 | 1,559,083.62 | 64,651,543 | 66,371 | 2.41 | 1.96 | 81.2 |
| 1936 | 219 | 1,718,548.21 | 81,291,076 | 71,372 | 2.11 | 2.01 | 94.9 |
| 1937 | 221 | 1,694,844.21 | 86,940,142 | 73,247 | 1.95 | 1.93 | 98.9 |
| 1938 | 226 | 1,763,446.86 | 98,070,604 | 76,569 | 1.80 | 1.92 | 106.7 |

TABLE NO. IV
ALL MUNICIPALITIES TOTALLED
DOMESTIC SERVICE

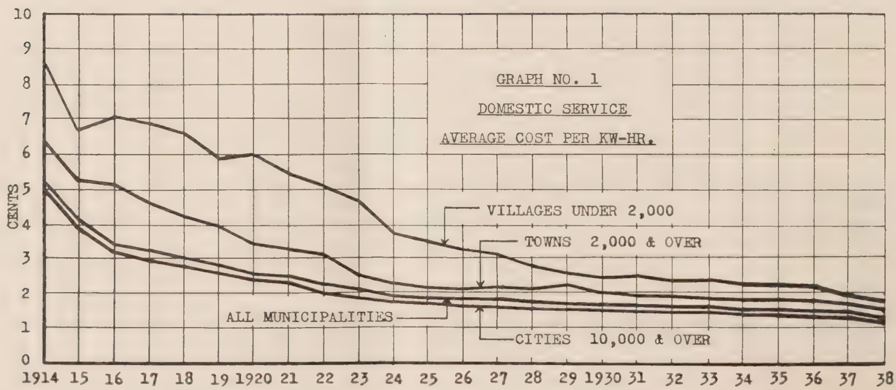
| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Consumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 49 | $ 730,168.00 | 14,359,100 | 64,866 | 5.08¢ | $1.06 | 21.0 |
| 1917 | 123 | 1,340,855.00 | 41,930,200 | 131,313 | 3.20 | .91 | 28.6 |
| 1920 | 166 | 2,514,658.00 | 98,211,000 | 193,892 | 2.56 | 1.15 | 44.6 |
| 1923 | 206 | 4,955,420.00 | 242,926,600 | 286,852 | 2.04 | 1.54 | 75.7 |
| 1927 | 267 | 8,497,190.79 | 469,851,690 | 387,573 | 1.80 | 1.87 | 103.5 |
| 1930 | 273 | 10,752,720.00 | 671,028,310 | 433,260 | 1.61 | 2.09 | 130.1 |
| 1933 | 300 | 11,639,178.12 | 742,195,402 | 460,878 | 1.57 | 2.10 | 134.2 |
| 1936 | 302 | 12,922,466.47 | 881,972,324 | 482,557 | 1.47 | 2.23 | 152.3 |
| 1937 | 305 | 12,680,921.58 | 926,350,703 | 490,140 | 1.37 | 2.16 | 157.5 |
| 1938 | 312 | 12,880,180.43 | 1,004,194,525 | 507,132 | 1.28 | 2.12 | 165.0 |

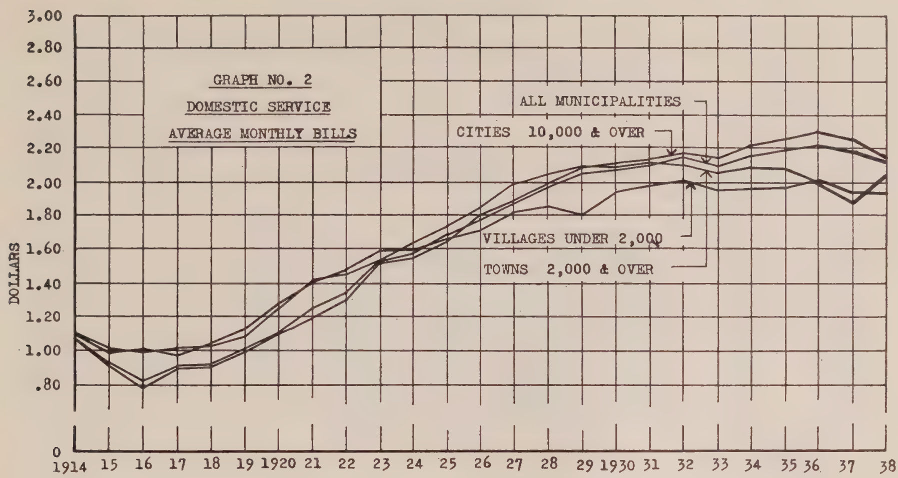
while the average monthly consumption has risen to 182.6 kilowatt-hours.

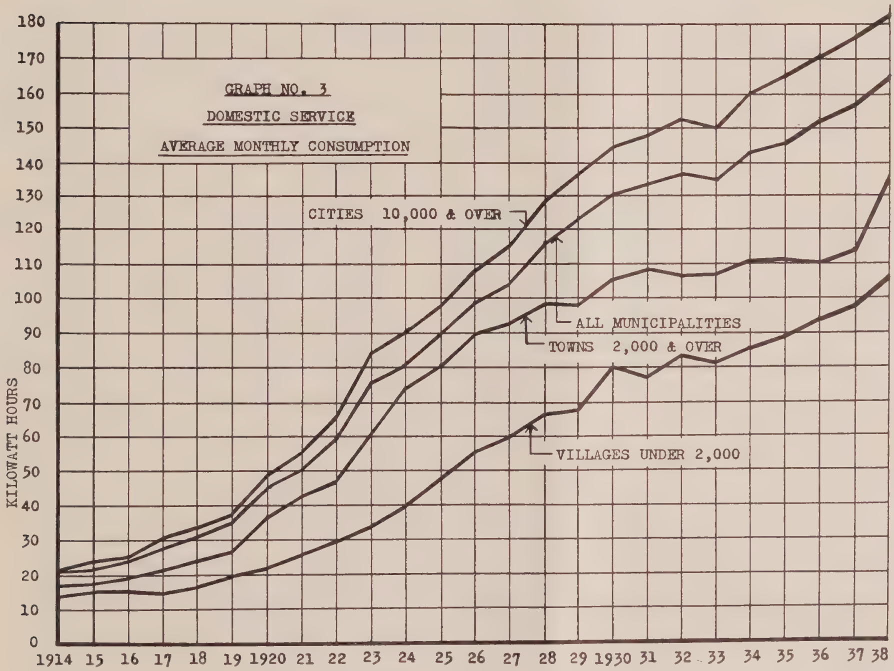
Table No. II shows that domestic consumers in towns have a greater increase in kilowatt-hour consumption than in previous years. The revenue increased, but the average cost per kilowatt-hour dropped to 1.49 cents, with an average monthly consumption of 137.5 kilowatt-hours.

Table No. III shows similar information for villages, but an average cost per kilowatt-hour of 1.8 cents, and an average monthly consumption of 106.7 kilowatt-hours.

Table No. IV gives a summary of all domestic consumers in all municipalities. The revenue is slightly less than that of 1936, but the consumption is more than 100,000,000 kilowatt-hours in excess. The average cost per kilowatt-hour is 1.28 cents, while the average monthly consumption has increased to 165 kilowatt-hours. It is interesting to note that the average monthly bill has remained almost level during the years 1929 to 1938, while the average monthly consumption has risen from 122.5 to 165 kilowatt-hours. It is also noted that the average monthly consumption for cities is






182.6; towns, 137.5, and villages, 106.7 kilowatt-hours.

The growth in the use of electricity by domestic consumers is also illustrated by graphs. Graph No. 1 shows the average cost per kilowatt-hour as given in Tables Nos. I, II, III and IV.

Graph No. 2 gives the variations in the average monthly bills from the same tables.

Graph No. 3 shows the growth in the average monthly consumption.

## TABLE NO. V

### Data for Cities over 10,000 Population

### COMMERCIAL LIGHTING SERVICE

| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Consumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 12 | $ 536,350.00 | 14,048,500 | 12,439 | 3.80¢ | $3.94 | 103.7 |
| 1917 | 19 | 642,989.00 | 27,479,800 | 19,573 | 2.34 | 2.96 | 126.6 |
| 1920 | 21 | 1,103,599.00 | 50,358,000 | 25,505 | 2.19 | 3.77 | 172.0 |
| 1923 | 21 | 2,043,197.00 | 91,146,500 | 32,016 | 2.25 | 5.56 | 246.9 |
| 1927 | 24 | 3,844,501.17 | 169,213,258 | 43,702 | 2.27 | 7.49 | 329.2 |
| 1930 | 26 | 4,919,496.00 | 242,278,308 | 50,046 | 2.03 | 8.31 | 409.6 |
| 1933 | 26 | 4,910,798.54 | 242,854,622 | 51,769 | 2.02 | 7.90 | 390.9 |
| 1936 | 26 | 5,673,317.44 | 298,250,755 | 52,058 | 1.90 | 9.08 | 477.4 |
| 1937 | 26 | 5,309,814.19 | 329,007,570 | 52,311 | 1.61 | 8.46 | 524.1 |
| 1938 | 26 | 5,439,553.40 | 353,678,032 | 52,986 | 1.54 | 8.55 | 556.2 |

## TABLE NO. VI

### Data for Towns over 2,000 Population

### COMMERCIAL SERVICE

| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Consumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 17 | $ 71,457.00 | 1,362,000 | 2,393 | 5.25¢ | $2.61 | 49.8 |
| 1917 | 27 | 134,730.00 | 3,100,600 | 4,107 | 4.35 | 2.76 | 63.5 |
| 1920 | 36 | 221,867.00 | 6,179,400 | 5,736 | 3.59 | 3.30 | 91.8 |
| 1923 | 43 | 315,530.00 | 9,598,000 | 7,086 | 3.29 | 3.76 | 114.3 |
| 1927 | 56 | 560,479.40 | 20,372,460 | 10,054 | 2.79 | 4.79 | 172.3 |
| 1930 | 54 | 661,857.00 | 27,841,568 | 10,274 | 2.38 | 5.38 | 226.4 |
| 1933 | 60 | 663,596.72 | 29,864,388 | 10,966 | 2.22 | 5.04 | 226.9 |
| 1936 | 57 | 687,355.93 | 32,957,583 | 10,600 | 2.09 | 5.40 | 259.1 |
| 1937 | 58 | 704,091.44 | 37,152,569 | 10,846 | 1.90 | 5.41 | 285.5 |
| 1938 | 60 | 750,601.74 | 42,243,795 | 11,159 | 1.78 | 5.60 | 315.4 |

## TABLE NO. VII

### Data for Villages under 2,000 Population

### COMMERCIAL LIGHTING SERVICE

| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Consumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 14 | $ 16,974.00 | 259,200 | 825 | 6.55¢ | $1.74 | 26.6 |
| 1917 | 77 | 82,756.00 | 1,403,100 | 3,773 | 5.86 | 1.87 | 31.7 |
| 1920 | 109 | 152,497.00 | 2,799,500 | 5,255 | 5.89 | 2.45 | 45.0 |
| 1923 | 142 | 254,530.00 | 4,738,100 | 7,281 | 4.80 | 2.96 | 55.1 |
| 1927 | 188 | 418,800.80 | 11,020,419 | 10,283 | 3.80 | 3.50 | 91.9 |
| 1930 | 193 | 513,518.00 | 17,718,146 | 11,553 | 2.89 | 3.76 | 129.9 |
| 1933 | 214 | 575,396.85 | 19,616,479 | 12,708 | 2.93 | 3.77 | 128.6 |
| 1936 | 219 | 641,220.20 | 24,027,215 | 13,220 | 2.67 | 4.04 | 151.5 |
| 1937 | 221 | 663,062.45 | 26,906,980 | 13,463 | 2.46 | 4.10 | 166.5 |
| 1938 | 226 | 719,298.87 | 32,440,178 | 13,876 | 2.22 | 4.32 | 194.8 |

TABLE NO. VIII

ALL MUNICIPALITIES TOTALLED

COMMERCIAL LIGHTING SERVICE

| Year | No. of Munici-palities | Annual Revenue | Kilowatt-Hours Consumed | Number of Consumers | Average Cost Per Kw-hr. | Average Monthly Bill | Average Monthly Consumption Kw-hr. |
|---|---|---|---|---|---|---|---|
| 1914 | 43 | $ 624,781.00 | 15,669,700 | 15,657 | 4.00¢ | $3.63 | 90.8 |
| 1917 | 123 | 860,475.00 | 31,983,500 | 27,453 | 2.69 | 2.77 | 103.1 |
| 1920 | 166 | 1,477,963.00 | 59,336,900 | 36,496 | 2.50 | 3.51 | 140.0 |
| 1923 | 206 | 2,613,257.00 | 105,482,600 | 46,383 | 2.46 | 4.80 | 195.6 |
| 1927 | 268 | 4,823,781.37 | 200,606,137 | 64,039 | 2.40 | 6.39 | 266.7 |
| 1930 | 273 | 6,094,871.00 | 287,838,022 | 71,873 | 2.11 | 7.15 | 337.8 |
| 1933 | 300 | 6,149,792.11 | 292,335,489 | 75,443 | 2.10 | 6.79 | 322.9 |
| 1936 | 302 | 7,001,893.57 | 355,235,553 | 75,878 | 1.97 | 7.69 | 390.1 |
| 1937 | 305 | 6,676,968.08 | 393,067,119 | 76,620 | 1.70 | 7.26 | 427.5 |
| 1938 | 312 | 6,909,454.01 | 428,362,005 | 78,021 | 1.61 | 7.38 | 457.5 |

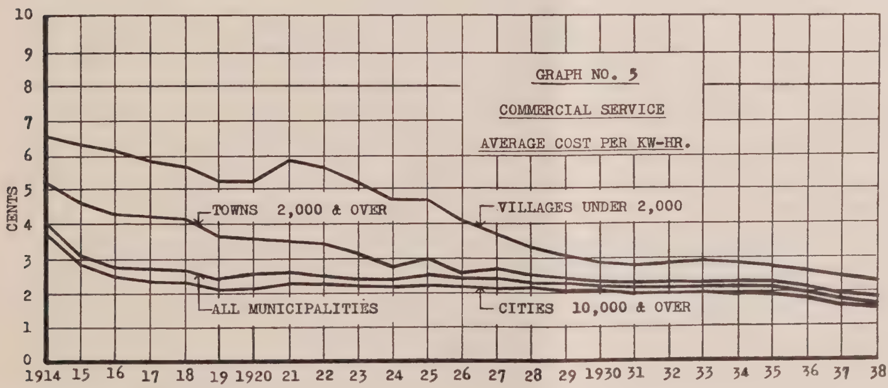
### COMMERCIAL SERVICE

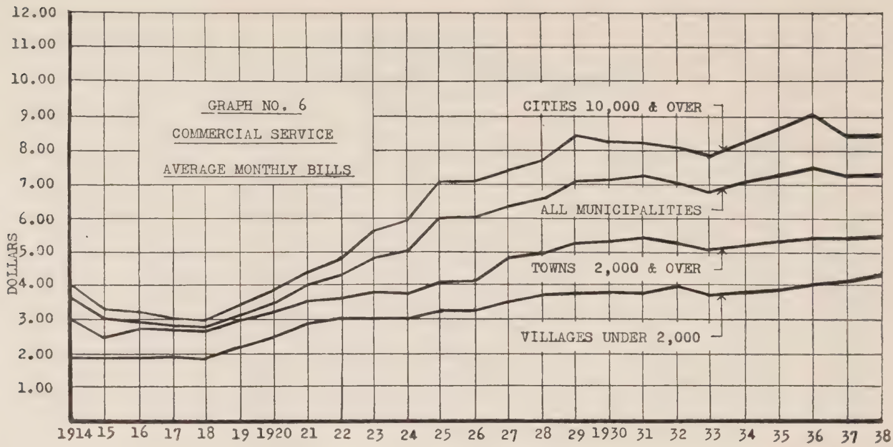
From the tables of revenue and consumption for commercial consumers will be seen the effect of improved store lighting and industrial conditions during the past few years.

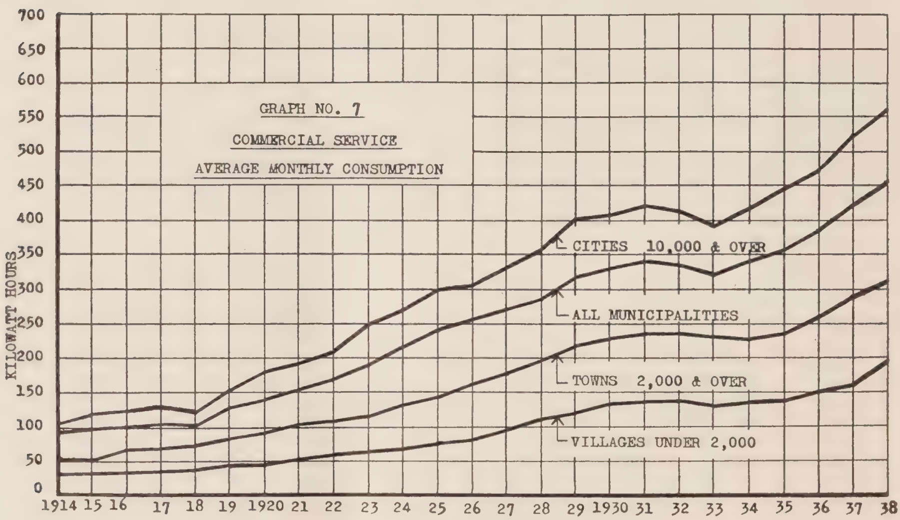
Table No. V shows a considerable kilowatt-hours increase in the cities, with the average cost per kilowatt-hour down to 1.54 cents, and an average monthly consumption of 556.2 kilowatt-hours. The average monthly bill remained almost level at $8.55.

Table No. VI for towns shows a suitable increase in both revenue and consumption, while the average cost per kilowatt-hour dropped from 1.9 cents in 1937 to 1.78 cents in 1938, with the average monthly consumption rising from 285.5 kilowatt-hours in 1937 to 315.4 kilowatt-hours in 1938. The average monthly bill was up slightly.

Table No. VII shows that commercial consumers in villages had a considerable increase in consumption, with a good raise in revenue, but the average cost per kilowatt-hour dropped from 2.46 cents in 1937 to 2.22 cents in 1938. The average monthly consumption rose from 166.5 kilowatt-hours in 1937 to 194.8 kilowatt-hours






in 1938. The average monthly bill was increased by only 22 cents.

Table No. VIII is a summary of all commercial consumers. While there was an increase of 1,200 consumers over 1937, the kilowatt-hours consumed showed an increase of 35,000,000 kilowatt-hours. Comparing the results with former years, it is interesting to note that the average monthly bill increased very slightly since 1929, while the average cost per kilowatt-hour dropped from 2.16 cents to 1.61 cents, and the average monthly consumption rose from 328.6 kilowatt-hours to 457.5 kilowatt-hours during that period.

The results shown in Tables Nos. V, VI, VII and VIII are graphically illustrated in Graphs Nos. 5, 6 and 7.

# Ice-Coated Electrical Conductors

By A. E. Davison, B.A.Sc., C.E., Transmission Engineer, H.E.P.C. of Ontario

SUMMARY

*Observations have been made of the boundaries of the orbits of points at the centre of a span of an ice-coated electrical conductor, when blown about by winds of the order of 30 miles (48.3 km) per hour. A few of these have been assembled, coordinated, and recorded, so as to facilitate the studies of those who may not have actually seen the phenomenon, but know something of the results of "Galloping", and are convinced, as a result of their investigations, that studies should be made and measures taken, within safe economical practice, by which it could be controlled or rendered less harmful.*

*Practical limits for these orbits are suggested. Application of these more conservative clearance diagrams to some familiar types of modern construction is so disturbing that engineers and operators may either abandon these diagrams as impractical, or change their ideas of economic phase spacings.*

*These suggested clearances are not an insurance, since conductor movements may be found outside these so-called practical clearance diagrams as the records herewith indicate, and since the fastenings and supporting structures may be damaged mechanically not long after the conductors would otherwise have flashed sufficiently to burn electrically so that they fall to the ground.*

*Brief references are made to other types of preventives and mitigants.*

## I.—Records of Effect of Wind Upon Glaze-Coated Electrical Conductors

"THE bottom crossarm of Tower 31 collapsed under heavy ice loading, taking 90 miles (145 km) of 110,000 volt circuits out of service, parts of which remained out of service for 118 hours while repairs were being made."

"The conductors were reported whipping together between poles 536 and 537 which accounts for the series of one-minute interruptions."

Such are the disturbing daily report forms that may reach the desk of a superintendent of one of the larger electric utilities whose transmission plant is spread over an area of from 25,000 to 50,000 square miles (64,250 to 129,500 sq. km). Investigations more frequently than not associate such occurrences with violent "galloping". The observed limits of some cases of this galloping are available for analysis.

Charts have been made of limits of travel from actual observations; other graphs have been developed by studying still and motion pictures of such occurrences. Moving pictures of some

Paper presented at the Conférence Internationale des Grands Réseaux Electriques à Haute Tension at Paris, France, on July 1, 1939.

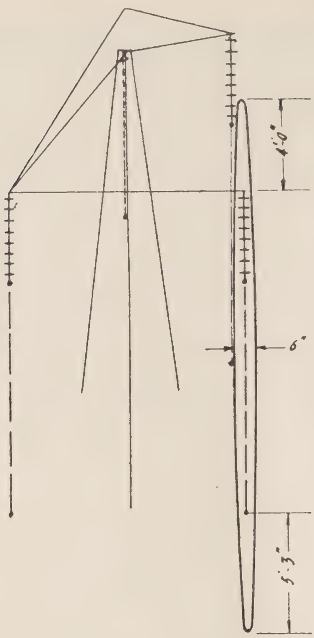



*Fig. 1—Galloping Power Conductors (Lissajous figures).*

*Observed Case: Galloping occurred in one phase only, the lower right phase. Line not energized at time of galloping. Wind 20 to 30 miles per hour. Glaze: Thin coating of ice on 50 per cent. of circumference of cable. 110 kv, 820,000 cir. mils all aluminium.*

ten to fifteen of them are now available. From these graphs, seven have been selected either as being exemplary or as illustrating some of the peculiarities of the phenomenon and they are herein described.

The records herewith are in some cases taken some time after the first outage or first structural failure occurred. Meanwhile the weather and wind conditions had changed, and although there was galloping, it was not particularly extreme. It should therefore be kept in mind that the loops were, at one time in the storm, much larger than were those actually recorded. They were so large and strenuous that the conductors flashed or conductors or fastenings failed mechanically.

Fig. 1 records an occurrence of 1928 near Niagara Falls. Circumstances peculiar to this observation were: the motion was almost wholly in a vertical plane; there was a thin glaze on one side only of the conductor; observers did not see the effects of gallop in one span transferred through suspension type insulators to an adjacent span; and only one of several cables between supporting structures was working at one time. When conductors were at rest, the clearances were 6½ feet (1.98 m), the sags ten feet (3.05 m), the spans 350 feet (106.7 m), and the conductors were 820,000 cir. mils (4.16 sq. cm), all-aluminium.

Fig. 2 is an observed case in which the deposit of ice and rime was irregular and had shapes that appeared to give results when acted upon by 30 miles per hour winds involving both "lift" and "drag" as described in most aeronautical studies of airplane wings. Peculiarities in this case were: there was considerable horizontal motion; the effect of the gallop was carried through suspension insulator supports, but affected adjacent spans less violently; and, as in Fig. 1, only one of several cables in a span was galloping at one time. Two or more cables were seen working during the course of the observation. It would not be good judgment to try to keep the circuit in service so long as any one of the conduc-

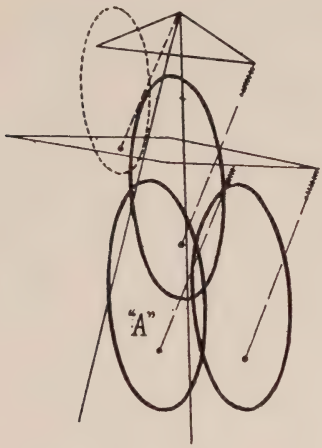



*Fig. 2—Galloping Conductors (Lissajous figures).*

*Observed Case: 110 kv "McGuigan" Suspension Tower. Conductor 312,000 cir. mils a.c.s.r. Erected 1916. Ground cable 5/16 in. galv. steel. Span 630 ft. Ice ½ in., irregular shapes. Wind 30 miles per hour. Whole span moved as one loop "A" (See "Dancing Conductors A.I.E.E. Convention", June 23, 1930).*

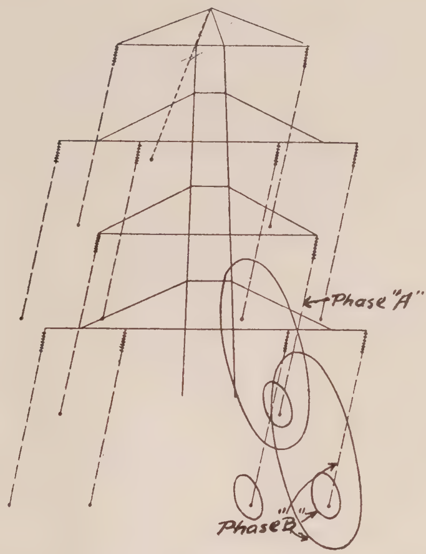



*Fig. 3—Galloping Power Conductors (Lissajous figures).*

*Observed Case: Ground cable ⅜ in. Copper-clad Steel. Conductor 605,000 cir. mils a.c.s.r. 30 mile per hour wind on ½ in. rad. ice. Span 780 ft. The typical figure used in discovering desirable clearances has been added to phases "A" and "B" only. These phases flashed. This disturbance accounted, during a subsequent inspection, for the records of small loops above, the galloping having evidently subsided in the meantime. A majority of the 13 cables galloped during observations as small loops at one time or another.*

tors of the circuit tended to give a demonstration of galloping.

The clearances and other characteristics were generally greater, but did not differ much from those in Fig. 1, although the observations were made at a quite different time but in nearby territory.

Fig. 3 is the result of examining the records, both "movie" and still, of gallop that remained in a group of conductors some hours after the first electrical flashover had occurred. The clearances, sags, and spans, though generally greater, did not differ much from those of Figs. 1 and 2. Superimposed, for the cables A and B only, are clearance orbits which are described later, and for which clearances should be provided in the more conservative types of construction. The fact that these conductors actually did flashover between phases confirms the opinion that greater clearances might have been provided for greater service security.

Fig. 4 records observations of low voltage cables having an insulated

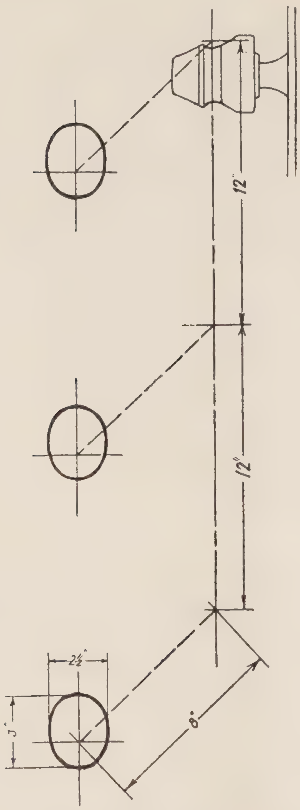



*Fig. 4—Galloping Conductors (Lissajous figures).*
*2,200 volt, 105,600 cir. mils weatherproof copper feeders. Line East and West. Observed Case: Wind 5 miles per hour. Glaze quite thin coating of ice.*

covering, wherein the sag was only a few inches for spans of about 100 feet (30.5 m). The loops in this case, almost as wide as they were long at the time of observation, do not appear to be of importance. It is a fact, however, that this mild gallop, at times a full span loop, and at other times having one node point, did tear insulators and metal pins from their metal fastenings prior to the observation.

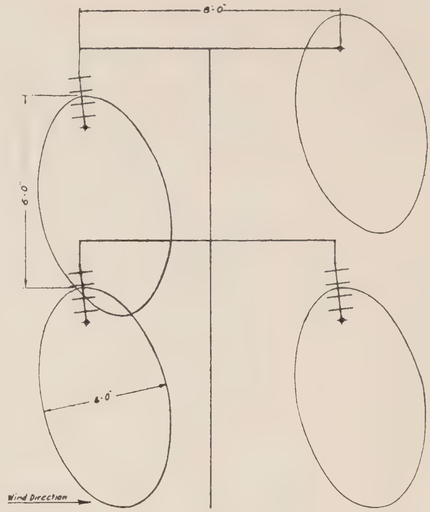



*Fig. 5—Lissajous of Galloping. 105,534 cir. mils a.c.s.r.*
*Observed Case: See Archbold Report, Electrical World, page 201, Jan. 26, 1929. Wind 25-30 miles per hour. Ice covered cables. Ice ½ in. thick. Icicles not over 1 in. long.*

Fig. 5 was reproduced from one of the earlier detailed descriptions of galloping by Archbold[1], observations having been made, according to the report, as early as 1914. The loops or orbits indicate what happened when this circuit flashed.

Fig. 6[2] records happenings in a span of cable to which artificial flaps simulating sleet were attached. This conductor looped as does a skipping rope. The direction of the looping should be especially noted as the work done on the individual wires of a conductor by this twisting action, at entrance to dead-end clamp for instance, may later be found to be of importance. Practical cases of this type of looping have been reported from the field. Such reports, and this

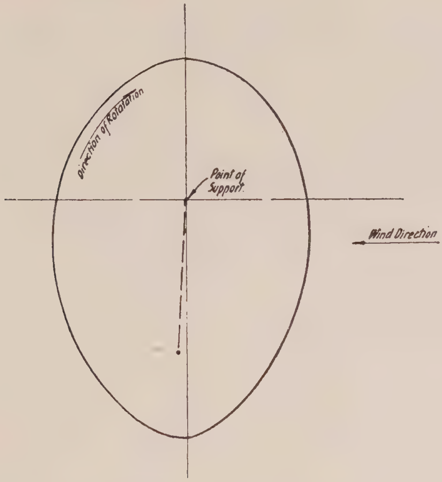



*Fig. 6—Path of centre point of conductor dead ended at each end and equipped with artificial flaps giving effects not unlike that observed in sleet storms. Practical case, see D. C. Stewart, Paper on Dancing Cables, presented at Northeastern District Meeting A.I.E.E., Buffalo, New York, May 5-7, 1937.*

record, indicate that clearances cannot be made economically for all possible cases of galloping.

Fig. 7 was produced so as to visualize conditions when two power conductors, having nearly vertical configuration and operating in quite level and exposed territory, flash under sleet coatings and light winds. Flashing was frequent and sufficiently violent in one only of the two circuits of a tower line during a glaze storm, that a decision could be made that the hundred-mile radial service would be served better with only one 110,000 volt circuit. The circuit that flashed several times was left out of service until a patrol was made (which incidentally yielded no information) and until the storm had subsided. As has been established in other cases, there might have been considerable merit in this case in deliberately overloading one circuit to such an extent that it would have been kept warm enough to limit further deposits of glaze. As the result of local information and of a more detailed patrol in good weather, flash marks were found in one span only. These were at approximately the quarter-span point, 180 feet (54.9 m) from the end of a 668-foot (203.5 m) span. The conductor was lowered to the ground and examined. The burns were fresh and were not sufficiently deep to warrant either cutting out or the addition of a split repair sleeve. The diagram shows what has been observed in other cases where flashes occurred at quarter-span points with galloping of comparatively small dimensions. One conductor has the larger loop added to show desirable clearances for galloping which, it should be kept in mind, may occur quite infrequently. This sectional outage did not cause an interruption to service. The pair of radial lines, some 102 miles (164.3 km) long, served with interruptions to service of less than one per annum for seventeen years, averaging only slightly over one minute per year for that period. There was one interruption during the life of these two circuits that totalled a little less than two hours during which clear phases were being selected. One of the circuits finally went back into service without any repair. That particular trouble was due to the irregular unloading of a quite heavy load of sleet.

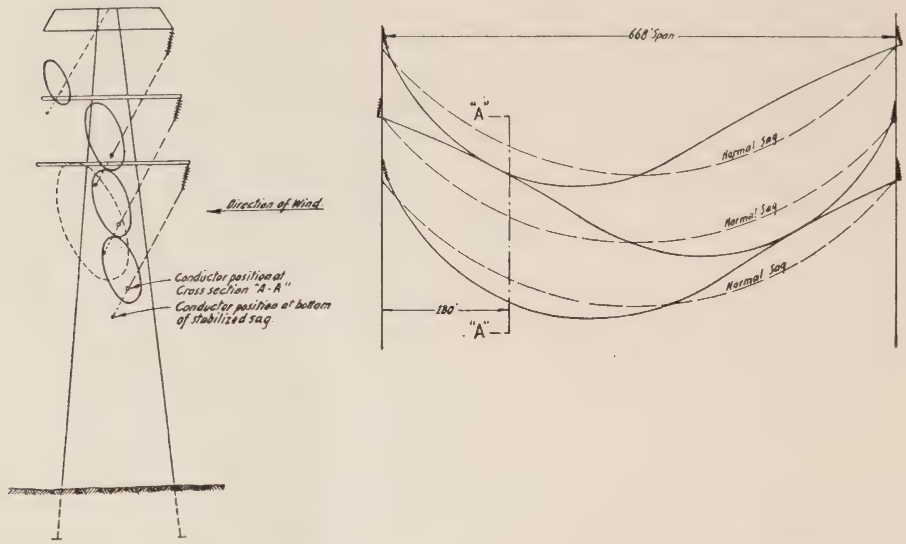



*Fig. 7—Galloping and outage occurred, December 31, 1937. Movement and flashing observed. Marks and local conditions studied after the storm. One of the two 110 kv circuits was automatically removed from service for six hours after the storm and was returned without mishap and after patrol which did not locate fault. Wind: 35 miles per hour. Sleet 5/8 in. max. radial thickness, generally on upper one half of surface only. Flash marks were found at a later date, having occurred 180 ft. from end of 668 ft. span. Galloping was evidently with one node at mid-span. Sleet remained on these conductors with no wind until after Jan. 10, 1938. The side view of span illustrates how conductors having nearly vertical configuration can flash when the loop is quite small. The galloping must be asynchonous. One only clearance loop at centre span which conservative designers might use is shown dotted.*

It should be noted in this case, that fatigue due to galloping is no respecter of conducting materials, copper being the conductor in this and some other cases. For a given tensile load, some types of material may have somewhat greater resistance to fatigue. Observations indicate that if galloping of electrically dead conductors persists over a long period of time, some type of mechanical failure will result.

## II.—Characteristics of Galloping

Although there are a number of specific records, sufficient cases have not yet been assembled to establish peculiarities of these smooth glazes on only one side of a conductor (*fig.* 1), wherein "Magnus"[3] or like effects are in evidence, as compared with thicker irregular coatings of ice and rime sometimes approximating the cross-section of an airplane wing (*fig.* 2). Observers, however, seem to associate excessive movements in the vertical plane, having very little if any horizontal motion, with thin glazes. They also seem to conform to the opinion that, in these cases, galloping is not transmitted appreciably

from an active span through the supports to an adjacent span. In the case of heavily coated conductors, the loops through which a point on the conductor near the centre of the span travels, have horizontal displacements, possibly due to gustiness or drag of about fifty per cent of the vertical limits.

Reporters seem to associate these phenomena with winds of the order of 30 miles per hour, and in one or two cases this has been checked by securing official readings from a nearby meteorological station. Wind velocities reported are doubtless only approximations. However, the most frequently mentioned is 30 miles per hour.

Galloping evidently can occur without glaze, and aside from electrical short circuits[4] there are a number of fairly authentic cases. It would appear that it can be produced in a wind tunnel when using a conductor having a uniform unglazed surface. Nevertheless, there is a tendency on the part of some investigators to confine their studies to the effects associated with glazed conductors. Other types of gallop are comparatively infrequent.

Experience indicates, incidentally, that it is good practice to investigate conditions intimately at the ends of all clamps and of all fastenings in any part of a line where gallop is known to have occurred. If galloping has created a weak spot in a conductor by tearing several strands of a cable apart or by excessive wear and abrasion of a conductor or tie wire, then aeolian vibrations, ordinarily quite slow in producing a fault, concentrate on the weakened spot and cause impairment or possibly failure in mild quiet weather.

Reports are available indicating that a glazed conductor has performed in the field as a skipping rope would, inasmuch as the mid-point rose as far above the line between points of support as it is below that line when at rest, much as was observed when using artificial flaps (*fig.* 6). This is exceptional, and indicates clearance limits that an economic designer cannot expect to reach.

### III.—Practical Lissajous[5] Figures

A large majority of the recorded galloping generally lies within an area having vertical displacements reaching an elevation one foot (0.305 m) above the line drawn between the points of support to a point a radial distance of 125 per cent of the loaded sag beyond (below) this line. It is preferable, in drafting these areas, to centre them on a stabilized radial sag line displaced from the vertical by that angle normally associated with a thirty-mile wind acting on the surface of the loaded (enlarged) conductor. The maximum horizontal displacements more frequently observed are, first, that the conductor, in a gusty thirty-mile wind, may swing to windward, back to the vertical, from its static position; second, that it may, when galloping in a gusty wind, travel a similar distance beyond, that is to leeward of, the static position.

These four limits for displacement establish four points on an elliptical orbit for the path of the centre point of a conductor. In the absence of a better clearance diagram, the above is submitted. Applications of it have al-

ready been made which indicate that it is possible to design reasonably within those limits. Many operating lines with which the author is familiar operate over fairly long periods without excessive outages. These lines may not have operated carrying glaze, during a period of high (30 miles per hour) winds. Nevertheless, it is freely accepted that certain more or less orthodox and modern clearances make either these orbits (Lissajous figures), or the clearances actually used on these modern designs themselves, appear ridiculous. Certainly one of these two ideas must be abandoned. If comparisons are desired, some of the more standardized clearances are described by P. H. Thomas[6] and by the *Standard Handbook for Electrical Engineers*[7].

It may be that relatively large (500,000 to 1,000,000 cir. mils) (2.53 to 5.06 sq. cm) conductors having spans of the order of 1,000 feet (305 m), radial spacings of the order of 25 to 30 feet (7.62 to 9.15 m) and sags (pendulums), including the length of suspension insulator, of the order of 40 to 45 feet (12.2 to 13.72 m), can scarcely be expected to operate in the exposed areas for long periods without flashing from phase to phase if there are any mechanical forces to move the conductors about appreciably. Combinations of glaze storms and following winds, across the line of thirty or more miles per hour, are quite infrequent and it may be, therefore, since interruptions are infrequent from this cause, that even conservative designers should not aim at such an expensive service.

## IV.—APPLICATIONS OF PROPOSED CLEARANCE ORBITS

Fig. 8 provides an opportunity to study the effect that the application of these orbits might have upon clearance diagrams for designers. The configuration conforms reasonably with the results of an effort to design an inexpensive steel-supported line using conductors having ultimate strengths of the order of 100,000 pounds (45,300 kg) and conductivity equivalent to that of say 150,000 cir. mils (0.76 sq. cm) copper. This configuration does not vary greatly from the use of sixty-foot (18.29 m) poles twinned with single horizontal crossarm erected so as to support suspension insulators at a point four to six feet (1.22 to 1.83 m) below the one or two earthed cables which may be erected at the top of the poles.

Three diagrams are shown. On the left, that sag for which the conductors, if the orbits were applied to it, might be kept clear of one another if there were no ground wire. The spans, of necessity, must be quite short, and there will be a relatively large number of structures per mile. Second from the left, a diagram is introduced to show the extent to which ground cable supports must be elevated above current practice in order to provide some assurance to the conservative designer that conductors will not flash, during sleet storms, to the grounded conductor. The diagram on the right shows what happens when the assumed orbits are applied to what appears to be current practice in configurations for modern lines that operate quite well most of the time. If any attempt were made

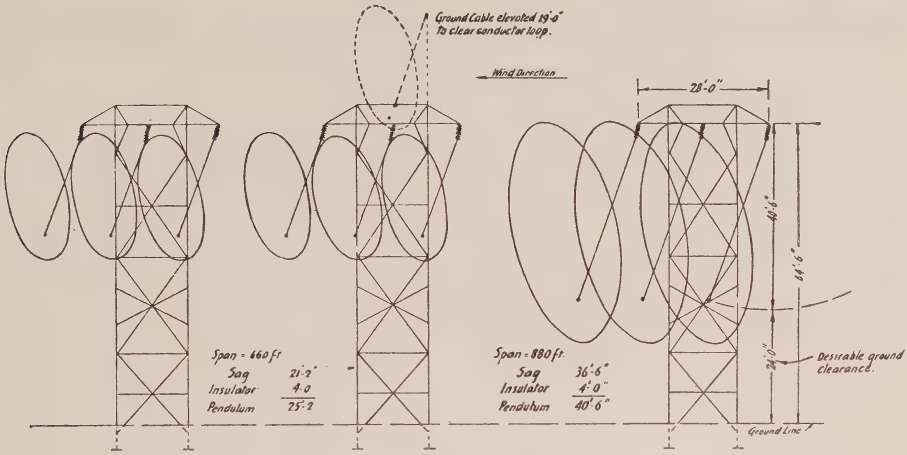



*Fig. 8—Comparison of span lengths using sags of 21 ft., 2 in. which may keep clear when galloping with sags of 36 ft., 6 in. with which high twin poles or steel towers are frequently used and where conductor spacing is of the order of 14 ft., 0 in. The spans change from 880 ft. to 660 ft. providing horizontal spacing is not changed. Heights for the same clearance to ground might be changed by 15 ft., 4 in. which is the difference in sag.*

to add a communication circuit to these poles or towers, then the clearances would be quite limited indeed.

Comparatively low cost lines can be built having radial spacing of the order of 5 to 7 feet (1.52 to 2.14 m), sags 25 to 50 per cent greater than the radial spacings, and spans of the order of 350 feet. Fig. 9[8] indicates one pole top of this type. There are many others, most of which involve short spans and may account for relatively greater costs, especially if the conductor chosen is large. For such lines, additional costs and annual charges, if any, may be considered by conservative designers and administrators as chargeable to security of service.

### V.—Mechanical Troubles

One notable objection to what may at first appear to some as being a comparatively expensive practice is that, in case severe galloping does develop in either type of line, or in case electrical burn-downs can be avoided by various means available, nevertheless the observed violence of the mechanical movement satisfies the observers that the system presently will be damaged, in some way, mechanically. This occurs usually at or near the fastenings, at points in the conductor or in the supporting structure, that have been weakened by aeolian vibrations or because of some other type of mechanical fatigue.

### VI.—Relative Importance of Galloping as Compared With Fatigue Due to Aeolian Vibrations

Aeolian vibrations are referred to only incidentally. The relative importance of these two problems to those who would study fatigue in electrical

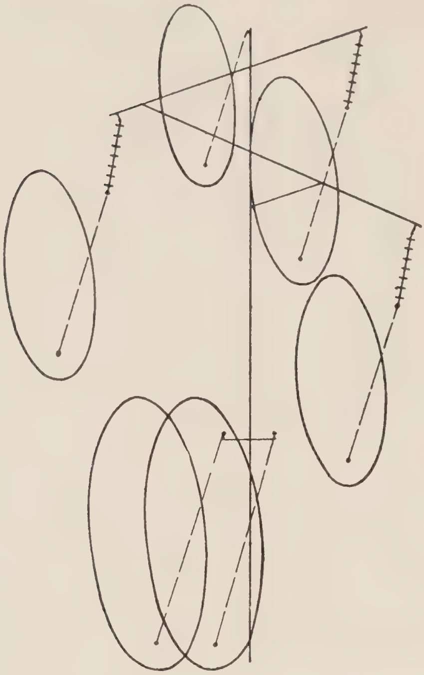


*Fig. 9—Application of Lissajous to "Wishbone" Construction. Conductors 211,000 cir. mils a.c.s.r. ground cable 9/32 in. galv. steel. Telephone 3 wire cable, each wire being No. 13 b.w.g. Span 325 ft.*

*This particular configuration operated on a 78-mile line from 1920 to 1939 with 4 outages (3 momentary), due to causes within the line itself. One of these, which was momentary, was attributed to gallop due to light, sticky snow load falling off unevenly. With minor modifications this type of construction has been used with conductors from 66,000 cir. mils a.c.s.r. to 336,400 cir. mils a.c.s.r. and in some cases like copper conductors. Standard spans were from 325 ft. to 400 ft.*

conductors is quite controversial and is not easily determined. There are examples of failures wherein both types have evidently been at work. High mechanical tensions seem to add to the troubles developing out of both problems.

## VII.—Alternatives That May Be Used to Improve Service Security

Alternatives by which service may be improved are quite limited. Among these are: artificial or accidental heating of conductors so that glaze cannot form; expensive loop systems so designed that there will be supply lines from two directions for all important loads, in the hope that sleet storms with following winds will not cause galloping throughout the whole district at one time; and underground systems.

High speed automatic reclosing breakers, which seem to improve service in districts where lightning is troublesome, may add to security of service under sleet and wind conditions.

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(7) *Minimum Horizontal Conductor Spacings* (*Standard Handbook for Electrical Engineers*, Sixth Edition, Section 14, 208, McGraw Hill, 1932).

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# Drying Out Flooded Electrical Machinery

By Engineers of the Operating Department, H.E.P.C. of Ontario

FOLLOWING the flooding of the Ontario Power generating station, (a 180,000 horsepower development of The Hydro-Electric Power Commission of Ontario, situated on the Niagara river at Niagara Falls, Ontario), on January 26, 1938, the Commission's staff was faced with the problem of returning this plant to service with a minimum of delay and expense consistent with the Commission's standard of maintenance. The conditions which had to be met were described in general terms in *The Bulletin* of June, 1938. Inasmuch as the June article dealt very sketchily with certain technical details which are of more than passing interest, the present paper deals with a number of these details in a more comprehensive manner. Naturally, drying out electrical equipment constituted a large part of the rehabilitation work and it is thought the experience gained by those actively engaged in this branch of the work will be helpful to others should they be faced with a similar problem.

Two methods of drying electrical equipment will be described, both of which were used successfully at the Ontario Power generating station. In both methods the machine is first washed down with a cleaning solvent, wiped as dry as possible, and the hand-taped insulation removed from the coil ends at the soldered joints to permit egress of moisture; the machine terminals are then disconnected before commencing drying operations. These methods are referred to as:

1. Hot air and internal heating.
2. Vacuum drying.

### 1. Hot Air and Internal Heating Method

In this method, drying is accomplished by producing evaporation of moisture through the circulation of hot air through the windings, the hot air supply being obtained through a combination fan and heater installation. Obviously, one of the first steps to be considered is the selection of the proper size heater and fan for any given machine.

#### *Selection of Fan and Heater*

The selection of the proper units is greatly facilitated by the use of the chart shown in Fig. 1, which has been prepared from a series of calculations and which gives the fan and heater size required to raise the temperature of the air to the desired value at various heating rates and for different weights of machines. This chart is used as follows:—

1. Determine the weight of the machine to be dried; the total weight of iron and copper will be close enough as a safety factor has been provided in the curves.

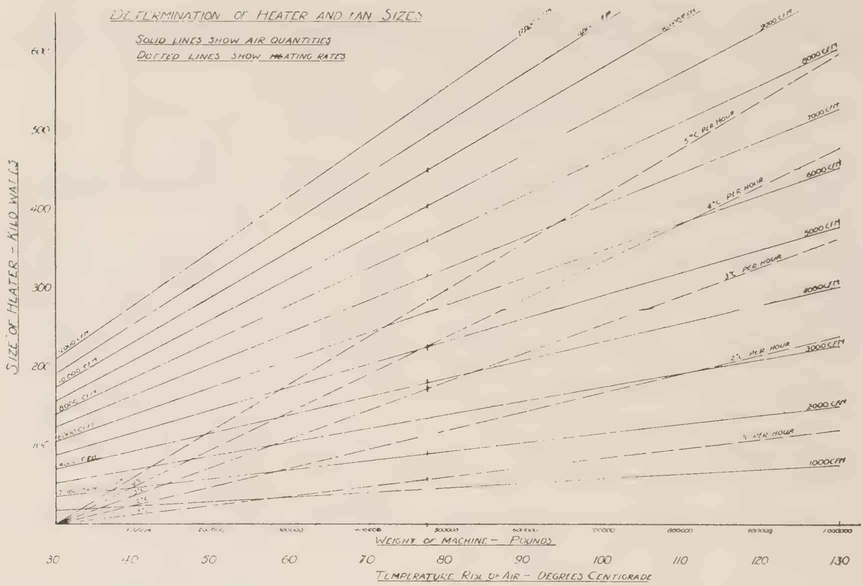


*Fig. 1—Heater and fan sizes.*

2. Decide upon the heating rate to be used; generally speaking, a low rate will be selected for the large machines to prevent mechanical strains through too rapid heating. For smaller machines a somewhat higher rate may be safely used. Rates in excess of 5 deg. cent. per hour are not recommended.

3. Having determined the values for (1) and (2) above, the size of the heater may be read directly from the chart by finding the point of intersection of a vertical line drawn through the weight of the machine as an abscissa and the dotted line corresponding to the rate of heating selected, and from this point following a horizontal line to the left to the heater size indicated.

4. Select the air temperature rise required. This should be done as follows:—

Assume the maximum allowable temperature of the winding 25 to 30 deg. cent. below the rated maximum for the insulation, as this should be a safe and satisfactory value for prolonged application of heat. To this figure add 35 deg. cent. which will offset the heat losses and produce a reasonable heating rate. The figure so obtained will correspond to the required temperature rise of the air. Using the heater size as determined in (3), find the point of intersection of a horizontal line through this point with the vertical line through the temperature rise required, and by means of interpolation between the fan capacity curves shown, the required quantity of air in cu. ft. per min. will be indicated. A fan capacity of about 10 per cent in excess of this value should be used to give ease of temperature regulation.

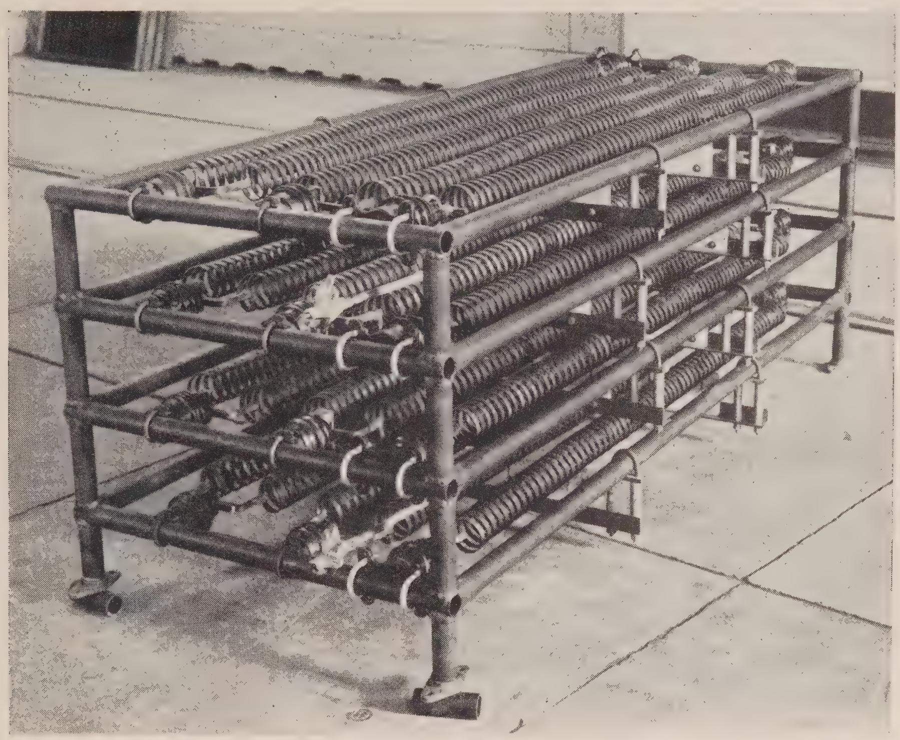

*Fig. 2—150 kw., 550-volt, single phase heater.*

### *Type of Heater*

Due to the high temperatures required for rapid drying, and for economic reasons, an electric element is practically a necessity for heating, and as fairly large heaters will generally be required they will probably have to be built specially for the job.

A satisfactory type of electric heater may be constructed, using ½ by ⅛ in. band iron for the element, which should not be worked at more than about 200 deg. cent. in order to remain within safe temperature limits for the iron. As the resistance of this iron is about .0091 ohms per foot at 200 deg. cent., the total length of iron required is readily calculated for any particular size heater at a given voltage from the formula:—

$$\text{Watts} = \frac{V^2}{R}$$

As the length of iron will be considerable, conservation of space is a factor and it will be found that some saving will be made by winding the iron in coils upon a 2 in. or 2½ in. mandrel and supporting the coils on an iron pipe framework by means of strain insulators. A 150 kw., 550 volt heater, constructed along these lines, is shown in Fig. 2.

### *Machine Enclosures*

In order to reduce heat losses and concentrate the heating, all windings

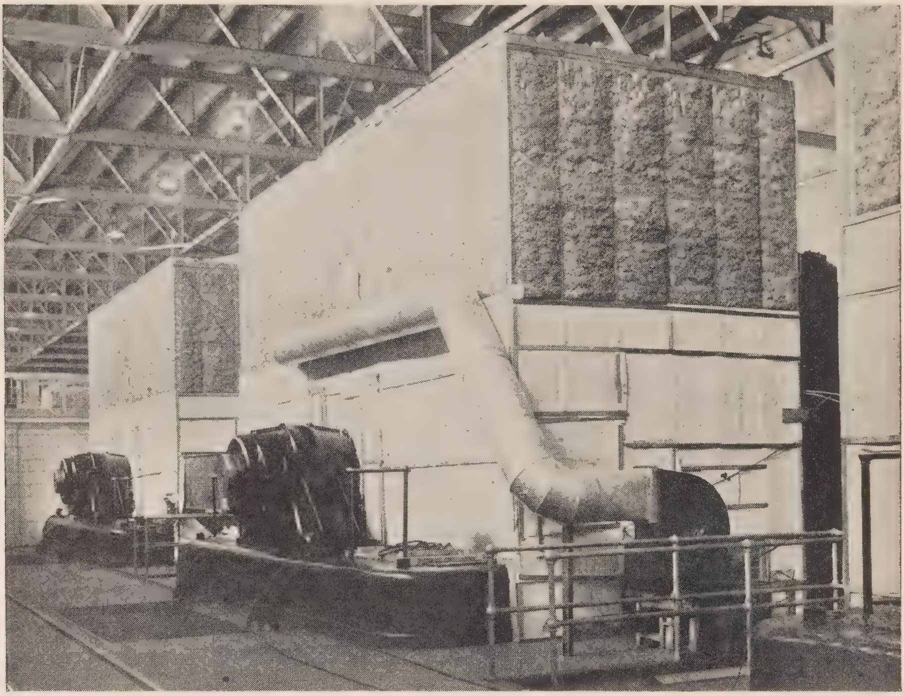

*Fig. 3—Drying enclosure for 9,000 kw. generator at the Ontario Power generating station.*

and iron of the machine should be completely enclosed. A frame house of 2 by 4 in. wood studding with ⅝ in. sheet insulating board used to form an interior lining for the studding, thereby reducing wall air friction to a minimum, makes an ideal enclosure. Economics permitting, rock wool insulation should be applied to the upper half and roof of the house, which may be held in place between studs by means of wire netting. The lower half of the house may be wrapped with asbestos paper, forming an air space between the paper and the insulating board. Since the materials used in the construction of such an enclosure will have a fairly high salvage value at the termination of the job, and as heat losses will then be kept to a minimum, the additional insulation is recommended.

The heat inlet opening to the enclosure should be as near the base of the machine as possible with ventilation openings provided in the opposite wall near the base and in the roof corner diagonally opposite to the inlet opening. Doors, preferably of the sliding type, must be provided for these openings so that correct air flow may be maintained and inlet air temperatures regulated. An entrance door to the enclosure should also be provided for purposes of inspection. Fig. 3 shows an enclosure of this type built over a 9,000 kw. machine at the Ontario Power generating station.

*Temperature Indicators*

Some means must be provided for measuring temperatures at various points on the winding surface, and if such indicators are not built into the machine, the easiest method of obtaining these readings is by attaching thermo-couples to the winding surface by means of putty. Couples should be located at the ends of the coils and should be placed in locations which will permit obtaining a complete survey of the machine temperature. This is necessary since the hottest point and temperature spread will govern the drying rate of the machine. It has been found by experience that the drying rate is materially increased when the whole machine is dried at a uniform temperature.

*Protection*

A thermal relay which will operate to shut down the fan and heater should be installed in the roof of the drying enclosure and at some point close to the heater. An air flow relay should also be used in the air stream to shut off the heater in the event of accidental shut down of the fan. These precautions are necessary to safeguard the machine against excessive temperatures which might permanently damage the winding.

*Operation of Equipment*

In this method of drying rotating machinery, four stages of operations are necessary:—

1. The initial heating-up period which is carried out with the machine at rest must be performed carefully to avoid cracking the insulation; this requires the selection of the proper size fan and heater to produce a proper heating rate. During this period, the machine is heated uniformly but as the machine temperature approaches the desired maximum, it will be found necessary to juggle the ventilation opening sizes. It may be found that the fan inlet must be partially blocked or that a new ventilation opening is required.

2. When it has been deemed that the insulation is sufficiently firm to withstand mechanical stresses set up from centrifugal force, the rotor of the machine should be rotated at about half speed. The only means of determining whether or not the insulation will withstand the stresses of rotation is by inspection. Insulation resistance tests should be made daily to follow the progress and effect of the drying. However, care must be taken to choose a suitable megger, one which will not produce a voltage high enough to damage weak insulation.

3. A synchronous machine, such as an alternator, should be stopped periodically and the field insulation tested. When the field resistance reaches about 1,000 ohms per volt of maximum field voltage, the stator windings should be short-circuited at the terminals and a weak field built up, preferably using a separate exciter as a direct current supply. This produces internal heating of the copper and tends to drive the moisture outwards to the coil surfaces and to the open ends of the coils. At this stage it becomes necessary to cut off the exterior heat and use the fan only, as otherwise excessive temperatures will result. The machine temperature is

then controlled by the amount of field excitation and cold air flow. In all probability it will be found that the bottom sections of the machine will be colder than the top, but this may be corrected by installing two or three small electric heaters in the pit under the base of the machine.

In the case of an asynchronous machine, such as an induction motor, internal heating should be provided by passing a direct current through the stator winding, using an exciter unit for this purpose since low voltage is required and the amount of current is limited by the maximum permissible insulation temperature.

4. In the fourth stage the daily megger tests of the insulation should be continued, and periodically, about every three days, a temperature run down test should be conducted upon the machine. This test consists of cutting off all heat and allowing the machine to cool to approximately 40 deg. cent.; while the machine is cooling megger insulation tests are made, noting the temperature at which each reading is taken. From these data the characteristic curve of insulation resistance against temperature may be plotted, using a logarithmic scale for megger readings and an arithmetic scale for temperatures. A typical curve obtained in this manner is shown in Fig. 4.

With moisture present, it will be found that a very definite break appears in this curve, usually between 55 and 65 deg. When this occurs it indicates that drying should be continued.

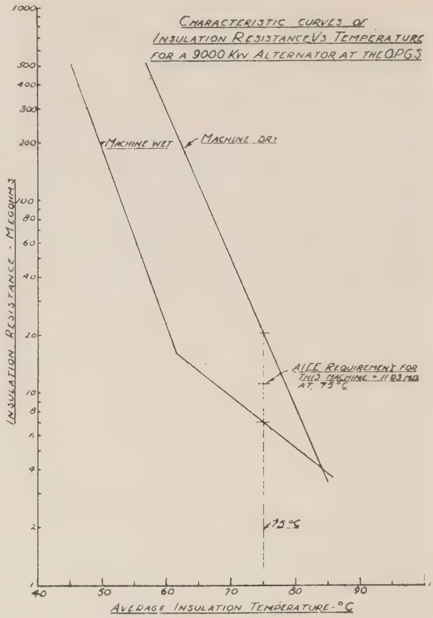


*Fig. 4—Characteristic temperature-resistance curves for wet and dry insulation. Note break at 61.5 deg. cent. in curve for wet insulation.*

When the insulation resistance has reached a constant value, the machine may be considered dry; it remains then only to reinsulate the ends of the coils, apply a high potential test, and place the machine on load.

During the drying operations at the Ontario Power generating station, a question was raised in regard to the possibility of moisture condensing on windings during the cooling tests; however, a little thought on this subject will show that trouble from this source is highly improbable, except possibly in tropical climates. It is impossible for moisture to form on a machine unless it cools below the dew-point temperature of the surrounding

air. Since large amounts of heat are being added to the air while the temperature of the machine is falling to 40 deg. cent., it is extremely unlikely that very high percentage humidity will be encountered, even during the period of maximum evaporation, and, therefore, there is little or no danger of moisture gathering upon the windings during a "decreasing temperature" test.

*(To be continued)*

# Georgian Bay Municipal Electric Association Meeting

PENETANGUISHENE was selected as the place for the Annual Meeting of the Georgian Bay Municipal Electric Association, but the Water and Light Commission of this enterprising and historic town planned differently. The meeting which was held on September 12th, took place on board the C.P.R., S.S. Keewatin, which proved a decidedly popular and attractive move.

The Executive met in the morning at the office of the Penetanguishene Water and Light Commission when final arrangements for the afternoon meeting were made. The delegates boarded the Keewatin at Port McNicoll and at about 2.30 o'clock the boat, with about 300 people on board, started for a cruise on Georgian Bay.

Immediately after the boat left her dock, John Kalte of Hanover, President of the Association, called the meeting to order in the Salon of the boat. Mayor Hatten of Penetanguishene welcomed the delegates to the convention. Before any business was introduced, Mayor A. J. Metzger of Hanover presented the following resolution:

"THAT this meeting of the Georgian Bay Municipal Electric Association place itself on record as heartily in accord with our Canadian Government in its position alongside the other members of the British Commonwealth of Nations in upholding our free and democratic form of government in opposition to force as a ruling and governing principle, and we pledge ourselves to do all in our power to strengthen and support them in carrying to a successful conclusion this conflict."

The resolution was carried unanimously and with enthusiasm and the entire gathering rose and sang the National Anthem.

The 1939 officers were re-elected for another year, viz.:

Honorary President—David Hurrie, Midland.

President—John Kalte, Hanover.

1st Vice-President—Alfred Menary, Grand Valley.

2nd Vice-President—R. D. Boyes, Alliston.

Secretary - Treasurer — H. S. N. Denef, Hanover.

Directors—Dr. J. Marcus, Kincardine; G. F. Hutcheson, Huntsville; C. J. Halliday, Chesley; W. Dixon, Arthur; J. F. Jackson, Barrie; R. J. Beaulieu, Penetanguishene; P. E. Byrne, Beaverton.

Messrs. R. D. Boyce of Alliston and William Brown of Meaford, were elected as members of the Board of the Ontario Municipal Electric Association.

C. J. Halliday, Chairman of the Chesley Public Utilities Commission, introduced a resolution which was carried unanimously, protesting against further taxation of public utilities and Hydro as such a move was contrary to the principles of Hydro, which was power at cost. It would cost too much money to collect such taxes and was merely taking money out of one pocket and putting it in another. If Ontario is to retain her premier position it must maintain the original principles of the scheme, principles which were fought for. He urged that the Association go on record as opposed to any further taxation and seek the co-operation of other bodies.

Other matters discussed were matters arising out of the war situation, power available for the Georgian Bay system and financial conditions. Engineers of the Commission's Municipal Engineering Department contributed the information and answered questions by the delegates. This discussion extended until nearly time for evening dinner; the boat returning to port at about 10 o'clock.

# Recalling Edison

## Some Notes on His Work

By A. P. Trotter, M.Inst. C.E., M.I.E.E.

EDISON did not pose as a scientific man, though he was generally regarded by Americans and by the American Press as the most eminent one of the day. He was said to pride himself on not knowing what other workers were doing, doubtless for the reason that in so doing he might be led away into matters of less importance.

Those who knew nothing of technical matters regarded Edison as a magician, and his inventions as the result of his marvellous intellect. Unlike the work of so many men of that day his work was not done single-handed; he freely employed assistants in his experiments and inspired them with his impetuosity. Put at some disadvantage by the exaggerated effusions of journalists, these were likely to prejudice other workers against him. He never passed off the work of his assistants as his own, but it was said that in his telegraphic days he produced the quadruplex system only by combining two existing duplex systems. On the other hand, the thought

that some one was stealing his invention roused him to fury.

He probably knew little, if anything, of the work of Star, Lodyguine, and of Sawyer and Mann in their attempts to produce incandescent lamps, while Joseph Swan was so well acquainted with them that he did not think that his lamp with a practical carbon filament was patentable.

### "Subdividing the Electric Light"

The success of public electric lighting by arc lamps and Jablochkoff "candles" was popularized in Paris at the exhibition of 1878, and this was followed by the great "gas scare." There was a financial panic both in American and English gas shares, for the world was thrilled in October, 1878, by the announcement that Edison had succeeded in "subdividing the electric light." Perhaps it would be more accurate to say that the American Press did all they could to thrill the world. This was in my last year at Cambridge, and I naturally took an interest in it.

In his patents of 1878 and 1879 Edison described a lamp with platinum-iridium filaments, and Lane Fox took a patent for a lamp with a similar filament in 1878, and pointed out the importance of a high resistance.

The selection of an alloy of these two metals suggests that the inventors took a crucible of one of the molten metals and then added and carefully stirred in the other. But the fact is that platinum in its native state always contains a number of other rare metals. In the process of refining, all these are dissolved away with acids, and the iridium which is very difficult to separate remains and does no harm.

Edison sent out twelve explorers in January, 1879, to search for platinum. In the same year Swan, who had experimented with carbon twenty years before this, and had abandoned it, succeeded, and showed lamps with carbon filaments at a lecture at Newcastle.

When Edison found that platinum-iridium was impracticable, he turned as others had done to carbon, and finding that thin strips of bamboo gave promising results, he dispatched three explorers to search the world to see if they could find a better vegetable fibre than bamboo for making lamps. I do not want to disparage his work. He made a brilliant display at the Paris electrical exhibition of 1881. Swan lamps may have been shown there as well, but I do not remember seeing them. Edison contributed very largely to the advance of electric light by popularizing it.

### Dynamos and Alternators

Nor do I wish to make adverse criticisms about his dynamos. In those days, and indeed until the paper by Dr. John Hopkinson and his brother Edward was read before the Royal Society in 1886, directing attention to the importance of the magnetic field, we were all building dynamos by eye. Edison may have had some such idea, and thought that the operation of the field magnets was in proportion to their length, and made them six diameters (over the windings) long. He preferred a number of small dynamos in a station to a few large ones (and Sir Alexander Kennedy's stations were noticeable for this). But Edi-

son, at first, went to extremes. In the authorized account of some of his inventions in *Scribner's* magazine, February, 1880, by his mathematician F. R. Upton, a view (no doubt imaginary) is given of a battalion of fifty dynamos in ten rows of five, set so closely together that there is hardly room to pass between them.

But two years later he had altered his views, and I was impressed when I saw the Edison dynamo used for lighting the Holborn Viaduct in London in 1882. I knew nothing about dynamo design in those days. The weight without the base plate is said to have been 20 tons, with more than 17 cwt. of copper in the armature and more than 13 cwt. on the field magnets. These consisted of two sets of four above and one set of four below (*The Electrician,* Vol. 9, page 200). It was rated at an output of 1,400 61 c.p. lamps; 8½ to the horsepower. I remember the driver in charge demonstrating the safety of the "Edison system" (compared with arc lamps) by laying his bare hands on the 110-volt d.c. terminals and "taking all the current through him." But the lamps did not blink.

He had made one excursion into the alternating current system in 1879. His alternator is described and illustrated in *The Electrician,* Vol. 2, p. 165. The account is taken from the French patent specification published in *The Engineer*. "It has been known that vibrating bodies, such as a tuning fork or a reed, can be kept in vibration by the exercise of but little power." He proposed to apply this principle to a tuning fork two metres long, vibrating 16 times per second. *The Engineer* observed: "Mr. Edison has probably succeeded in producing the very worst magneto-electric machine ever made—that is to say, if he really has ever constructed one according to his specification, which we much doubt." The drawing shows that considerable attention must have been given to it, and this the more indicates the inventor's lack of acquaintance with scientific or even mechanical principles. I have seen no estimate of the proportion of Edison's inventions in the years 1877 to 1880 that never passed beyond the stage of patent specifications, but it must have been great.

### Carbon Button Telephone Transmitter

His invention of the carbon button telephone transmitter in 1878 seems to have been made at about the same date as and quite independently of Prof. Hughes' microphone. There is an interesting distinction between the two. Edison must have the credit for beginning on sound scientific principles, depending on the variation of the electrical resistance of certain substances with mechanical pressure. With his assistant, Charles Batchelor, and the use of a Rutherford diffraction grating and a microscope he examined the surface of a button made of lamp black in 1877. I do not suppose this helped, but it is of interest to read of it. Twenty-six illustrations of different kinds of telephone transmitter are shown in *The Electrician,* Vol. 2. All this work was to improve upon and to compete with the Bell telephone.

Prof. Hughes made a long series of experiments introducing magnets,

without apparently any important application to his original discovery of the microphone, the result of light contact. I remember hearing him talk to a pile of iron wire nails. Someone asked him, "How is a microphone made?" He replied, "The difficulty is not to make a microphone."

I am inclined to think that the invention was the careful application of an accidental discovery. At one end of the telephone instrument of to-day there is a microphone differing very little from that of Hughes, and at the other end a receiver even more closely resembling that of Bell. I myself made a pair of Bell telephones in October, 1877, and used them at Cambridge. Edison was very indignant when he heard of the Hughes microphone, and declared that the idea had been stolen from him.

### Phonograph and Zoetrope

The vibrations of the human voice had been recorded by the trace of a needle on smoked paper by Koenig's phonautograph, but the phonograph seems to have been Edison's most original and complete invention. My friend, Louis John Crossley, of Halifax, had one of the original pattern using a sheet of tinfoil. I heard it in 1884, and it spoke more distinctly than some of my friends speak to-day on the telephone. I had a great difficulty in finding one for sale in London in 1923. It was still a toy, but soon after that the Dictophone appeared with very little modification of the Edison invention. It is said that when the first phonograph had been made, Edison locked the door, seized the handle, and said, "Nobody leaves this room till the thing talks!"

The zoetrope had long been known for a toy, and even in Maxwell's hands remained a toy. Somewhere in these busy 'seventies Governor Leland Stanford of California, owned a private racecourse, and being a breeder of race horses he wished in a most scientific spirit to study their action in running. After many costly experiments, Muybridge, a San Francisco photographer, set up twenty-four cameras standing one foot apart. Electrically released shutters were sprung by the breaking of a thread from each camera as a horse passed it. The results were excellent, and a study of the theory of the anatomical action was made by Dr. Stillman and published in 1882. Mawson and Swan were beginning to make gelatine dry plates in about 1877, but I do not think that continuous films came in until about twelve years later. Edison with his visionary powers saw the possibility of applying photography to the zoetrope and helped to develop it, and when he died in 1931 the gramophone and cinema had become important features of civilized life.—*The Electrical Times.*

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**The Hydro-Electric Power Commission of Ontario**

# THE BULLETIN

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# Current Review of Matters Affecting the Eastern Ontario System

By Dr. T. H. Hogg, Chairman,
The Hydro-Electric Power Commission of Ontario

IT was my pleasure and privilege a year ago, to attend and address a meeting of this Association in Belleville. I am pleased to be meeting with you again today, and to review very briefly a few matters of current interest affecting the Eastern Ontario system.

Before I do this, I should like to extend to you, Mr. Mayor, and citizens of Campbellford, my own personal congratulations and those of my fellow Commissioners on this, the golden jubilee of the founding of the town of Campbellford. While Campbellford is not one of the municipalities participating directly in the Hydro enterprise, it is so situated geographically as to be closely linked with that enterprise. I think that I can safely say that there has always been a spirit of friendly co-operation between the Corporation of the town of Campbellford and The Hydro-Electric Power Commission of Ontario, and that this co-operation has been mutually advantageous. I am confident that this same friendliness will characterize our dealings in the future.

As you know, my remarks at your district meetings usually take the form of a brief résumé of events which have or are expected to transpire. Today the principal items in my notes relate to new legislation, load trends, new transmission lines, future power resources, and finances.

### The Power Control Act

At the special session of the Ontario Legislature held last month new legislation known as The Power Control Act, 1939, was passed. Under this special war-time Act The Hydro-Electric Power Commission of Ontario is

Address to Eastern Ontario Municipal Electric Association at Campbellford, October 18, 1939.

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Vol. XXVI No. 10
October, 1939



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

given authority to regulate and control power in Ontario; this control includes the generation, transformation, transmission, distribution, supply and use of all power in the Province. The object is to give the Commission the authority to restrict, prohibit and apportion the supply of power in order to effect the most economical, efficient and equitable use and distribution of power for the duration of the war.

There is no need for me to go into the technicalities of this Act—suffice it to say that it augments and implements The Power Commission Act, virtually making the Commission power controller for Ontario with full authority to deal with all questions of power whether generated by the Commission, by private companies, or by other public bodies.

During the Great War many of you will remember that there was a shortage of power, and that a restriction had to be put on its use for street lighting and other purposes not essential for the production of war materials. We do not look for a repetition of these conditions during this present war, but The Power Control Act has been put into effect in order that the Commission may put the total power resources of the Province to the best possible use.

### LOAD TRENDS

The trend of primary load on any power system is one of the most reliable indices of the industrial well-being of the territory served. I am pleased to say that the primary load of the Eastern Ontario system has continued the substantial growth which has characterized the past five years, during which an increase of approximately 50 per cent has occurred. Last year the maximum primary load amounted to 132,000 horsepower. Greater than average growth is indicated this year. In September the maximum primary load exceeded 141,000 horsepower, and while accurate predictions as to the future demands are difficult to make, under present unsettled conditions, it would not be surprising if the maximum primary demand next December were to exceed 150,000 horsepower, a growth of nearly 14 per cent.

### NEW COST MUNICIPALITIES AND NEW CUSTOMERS

The attractions afforded by the Eastern Ontario system to industrial

enterprises of size and importance seem to be obtaining greater recognition.

As many of you know, The Aluminum Company of Canada is proceeding with the construction of a large rolling and extrusion plant at Kingston, Ontario. Contracts have been concluded between the Company and the Commission for supplies of firm and interruptible power. It is expected that this plant will commence operation early in 1940, with an estimated total demand well in excess of 5,000 h.p. and a possibility of reaching some 10,000 h.p. in the early future.

A contract is also in process of negotiation with the Honorary Advisory Council for Scientific and Industrial Research for a supply of power to the projected National Research Laboratory at Ottawa. In addition it appears almost certain that new connections will be made to many smaller customers and many existing customers will increase their plant and power requirements.

The municipalities of Eastern Ontario which appear to desire to remain outside the Hydro family of cost customers are becoming few and far between. This year, three additional municipalities—namely Orono, Millbrook and Arnprior have signed cost contracts — and four more — Frankford, Omemee, Iroquois and Newburg —are negotiating or inquiring into the matter. As the matter now stands, other than Campbellford — which of course has an adequate municipal supply of its own—Cornwall is the only city or town of importance not securing the benefits of power at cost together with the equity earned through the accumulation of reserves.

### Rural Development

During the past year extensive rural line additions have been made. Up to the end of September the Commission had approved of the construction of 753 miles of new rural line to serve approximately 2,900 additional consumers.

The total number of rural consumers now served on the Eastern Ontario system is approximately 22,460, while the rural peak for the year amounted to 11,461 horsepower, an increase of 23.2 per cent over last year.

### Power Resources

The normal dependable peak capacity of the combined power resources at present available to the Eastern Ontario system, exclusive of the Chats Falls frequency-changer set, is approximately 150,000 horsepower. As already pointed out, there is good reason to expect that the load next December may reach this same figure, in other words that during the coming winter the load will fully utilize the capacity of the existing generating stations and purchased power contracts, and that further load increments in 1940 will have to be supplied by the Chats Falls frequency-changer set.

While the frequency-changer fulfils a unique and extremely valuable function in so far as the Eastern Ontario system is concerned, it should be borne in mind, that it was not the intention of the Commission that it be considered a permanent source of primary base power for the Eastern Ontario system. It was originally intended to make available to either the

Niagara or Eastern Ontario systems any excess resource on the one, that could be used to advantage on the other, whether for the purpose of normal supply or emergency reserve. Neither system was expected to assume any obligation to make available a continuous supply to the other for a period of years.

The Niagara system will be in a position to supply through the frequency-changer set the primary needs of the Eastern Ontario system until the late fall of 1941, but during the years immediately following there is no assurance that it will have any excess primary resources. This being the case, the Eastern Ontario system must be in a position to take care of its own load, though not necessarily its full reserve, by the fall of 1941.

In any case it would not be to the advantage of the Eastern Ontario system to be dependent upon an unusually large block of primary power derived from a single unit of relatively large capacity such as the Chats Falls frequency-changer, for the reason that, although of good design, a serious fault in any of the component parts of this machine might render it unavailable for a rather long period, leaving no reserve to offset its loss.

As against this, it is economically to the advantage of the Eastern Ontario system to take a certain amount of primary supply from the Niagara system for perhaps a year prior to the development of a new generating station, for this tends to increase the load which will be supplied by the new generating source when it is put into operation and thus reduces the cost of power derived from it.

In my opinion it is reasonable and proper to take the Eastern Ontario system's additional power needs during the winter of 1940-41 from the Niagara system through the frequency-changer set, but it is also necessary to obtain from some other source a substantial block of power by the fall of 1941. The time has now come to decide where this additional block of power shall come from. Studies made by the Commission's engineers show two possible sources of generated power that can be developed within the time available; first, the Trent and Otonabee rivers and, second, the Madawaska river.

The Commission owns or has the option of acquiring the rights to develop a number of additional power sites on the Trent river and its tributaries, having an estimated total capacity of 15,000 horsepower. Individually each of these sites is of relatively small capacity and none of them can be developed to produce power at a cost which would compare favourably with the better Madawaska sites or with the cost of power being purchased under existing contracts. However, several of these sites are located close to existing transmission facilities and important load centers and their development may be justified largely as a matter of service security to the immediate district. Furthermore, development of the remaining power sites on the Trent would enable a more complete regulation of the river flow, and would result in the most efficient use of the Trent resources for power development.

The problem of obtaining the most efficient use of the flow of the Trent

watershed by our existing developments on the river was given considerable study by the Commission's engineers a few years ago. As a result of this study a general agreement for the co-operative use of the river for navigation and power was effected in 1937. Since then details have been receiving attention, and it is expected that the benefits of the agreement in a more efficient use of the available water will materialize shortly.

The alternative to development on the Trent is development on the Madawaska. As pointed out in my address to you last year, the Commission's power sites on the Madawaska afford a favourable opportunity for progressive development in accordance with system needs. While these sites are somewhat larger than those on the Trent and would call for a slightly greater initial expenditure, there can be no doubt but that they are the more advantageous.

Although the final decision has yet to be made, I want you to be fully aware of the facts and the alternatives under consideration, and I particularly want you to view this problem from the standpoint of our present knowledge. The Eastern Ontario system must be provided with additional power so that it may continue to attract industries and be able to afford the full benefit of the ever-increasing demand of electrical service in the home and on the farm. The transitory nature of war industries and war activities must also be taken into account. The war may go on for years or it may terminate unexpectedly. When it does end, not only the Eastern Ontario system but other systems of the Commission may suffer a considerable setback; their demands may not only cease to grow but may actually decrease. At this moment no one can tell how long the war will last or how great the power requirements of these various systems may become before the aftermath sets in. We are, therefore, faced with the decision which must be made *now* respecting a future which is uncertain. If, in the light of subsequent events, it may appear that some course other than the one which we have taken would have been more advantageous, it should not be inferred on that account that we were unwise to make provision now for a future increase in demand which seemed so probable. As already stated, our final decision has not been made but I am prepared to say that an early development of the High Falls site on the Madawaska river is probable and that before actually committing ourselves to this development you will be given further advice concerning it, not with a view to evading our responsibilities by laying them on your shoulders, but simply to keep you fully informed and enable you to voice any opinions you may wish to have taken into account.

### EXTENSION OF HIGH VOLTAGE TRANSMISSION FACILITIES

The limitations of the existing 44 kv. single-circuit transmission line between Belleville and Kingston, which is the sole connection between what may be considered as the eastern and western divisions of the system, have long been a cause of concern. To provide adequately for growing load, to reduce transmission losses and to greatly improve the dependability of

service to virtually all consumers, the Commission has authorized the construction of a new fifty-seven-mile 110 kv. transmission line from Frontenac transformer station near Kingston to Sidney transformer station at Trenton, and also a new thirty-mile 110 kv. transmission line from Chats Falls to Ottawa. By the construction of these circuits a 110,000-volt loop will be created. In effect this loop will provide a two-line interconnection of substantial capacity between the eastern and western divisions of the system, making the power resources of each division fully and dependably available to the system as a whole. The northern portion of this loop has been located so that it is conveniently available to take the output of the probable initial developments on the Madawaska river.

These new circuits together with the existing 110,000-volt lines will constitute a very effective trunk transmission system around which extensions of the Eastern Ontario system's transmission network will be designed. The construction of these circuits and the completion of the trunk system will mark the fulfilment of a plan which has been our objective for some time and one which is recognized as bringing material advantages to the system.

The load in Oshawa and vicinity has now increased to the point where voltage regulation is becoming a problem and transmission losses an item to be reckoned with. The second and newer line between Trenton and Oshawa now operating at 44 kv. was constructed so that it might be operated eventually at 110 kv. and, as it is expected that it will be necessary to resort to the higher voltage at an early date, authority has been granted to increase the insulation on this line while outages may still be obtained without seriously inconveniencing consumers.

The estimated cost of the foregoing extensions together with necessary switching equipment and regulating transformers is $1,050,000.

### Effect of Expenditures on Power Costs

The question uppermost in your minds during this discussion of authorized and probable future construction, may have to do with finances. What effect will these new expenditures on capital account have on the power rates of the system?

To answer this briefly, let us make some comparisons. For the fiscal year ending October 31, 1938, revenue from the Eastern Ontario system exceeded cost by $2.27 per horsepower. In the present year costs have increased by $100,000 payable for an additional 18,000 horsepower purchased from the Gatineau Power Company. This increase in cost will be offset by additional revenue attributable to growth in load, so that the overall financial result this year will be much the same as last year. Revenue should exceed costs by at least $2.00 per horsepower—notwithstanding the fact that twenty-five Eastern Ontario system municipalities received interim rate reductions effective this year.

The additional capital investments for transmission lines already mentioned will increase expenses during the coming year ending October 31,

1940, by an amount depending upon how soon these facilities are placed in operation, and there will be some small additional expense for energy to be taken from the Niagara system through the frequency-changer set. Here again the increase in expenses will be offset by increases in revenue. According to present estimates they will be more than offset. The increase in revenue from an estimated 8 per cent increase in ordinary load and from the additional 5,000 horsepower to be supplied to the Aluminum Company, is considerably greater than the estimated increase in cost. Unless these estimates should prove to be in error, revenue during the coming year should exceed expenses by something in the order of $3.35 per horsepower.

I think we all expect that for the duration of the war Canada will experience a period of materially accelerated industrial activity; there should be little unemployment and the average man will probably have money to spend. Under these conditions, there is every reason to believe that the Eastern Ontario system as a power enterprise will prosper and that, on the average, the revenue, collected at the present interim rates, will continue to exceed the cost of power, thus creating a surplus each year. The proper disposition of these additional funds which may be expected to become available annually is a matter of importance and I want to make my views on this subject unmistakably clear.

In my opinion it is important to increase the system's reserves and financial stability in order that ample funds shall be available to enable it to weather any possible period of depression which will almost certainly follow the war. Eastern Ontario is steadily becoming more industrialized. By comparison with peace-time activity, war loads will be of greater magnitude than formerly and in consequence the transition to peace-time conditions may be much more difficult. Bearing this in mind, the Commission does not contemplate returning to the municipalities the additional funds which may be expected to come into their possession through the maintenance of the present interim rates and the present magnitude of thirteenth credits. On the contrary, it is our present intention to make increased levies on these funds, whenever possible, to be placed to the credit of the rate stabilization and contingency reserves funds.

### Conclusion

In conclusion, let me caution you against any tendency to alarm or pessimism in consequence of my remarks upon the need for protection against possible lean years following the war. While Eastern Ontario is becoming more industralized and in consequence more susceptible to setbacks during years of industrial depression, it is still a very stable territory. The question of whether or not to set up reserves and how much reserves to set up, depends upon the readiness with which funds may be made available for those reserves. I am not suggesting that the system cost of power be increased in order to increase the annual contribution to reserves, but I do feel that it is no more than prudent to utilize the greater part of any surplus funds which may become

available to materially augment the system's reserves, when it can be done without increasing the net cost of power to the municipalities. Notwithstanding this, I have not the slightest doubt but that the Eastern Ontario system will emerge from the war period and from any period of depression or recession that may follow, stronger than ever before, and it is to make very sure of this important end that I and my colleagues propose to take the prudent course of substantially building up your reserves.

## A. K. McIntosh, Cobourg

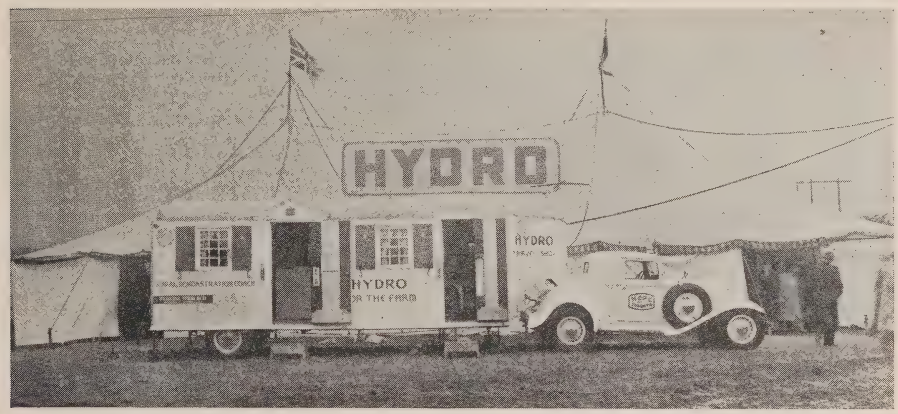
Effective on November 1st, 1939, A. K. McIntosh has been appointed manager of the Cobourg Public Utilities Commission.

*A. K. McIntosh.*

Mr. McIntosh was born in Coldsprings, seven miles north of Cobourg, where he attended public school, later attending Cobourg Collegiate Institute. In 1912 he entered Queen's University, taking the course in Civil Engineering. On the completion of his third year he enlisted in the Cobourg Heavy Battery, serving in France with the 2nd Canadian Heavy Battery, and for his meritorious action was awarded the Distinguished Conduct Medal. On his return from overseas he was engaged by the Commission for the summer of 1919 on survey work at Chippawa, after which he returned to Queen's University and graduated in the year 1920.

During the next five years he was employed on surveys for the Commission on the Ottawa and St. Lawrence rivers. In 1925 he joined the staff of the Fraser Brace Engineering Company as assistant engineer, and in 1930 was employed by the Ontario Power Service Corporation as field engineer during the construction of the Abitibi Canyon Power Development, continuing in that capacity with the Commission when the development was placed under its administration in 1933. Since that time he has served the Commission in various capacities, generally acting as field engineer or resident engineer on construction.

During his years of service with the Commission his talents and pleasant personality have earned a wide circle of admirers and friends, and he will carry with him their fervent wishes for success in his new position.




*Hydro tent and travel shop.*

# The International Plowing Match

THE international plowing match and farm machinery demonstration of the Ontario Plowmen's Association, was held this year on the Ontario Hospital farm and adjacent properties north of Brockville on Tuesday to Friday, October 10th to 13th. The attendance was considerably smaller than in previous years, due largely to the weather.

The concession area occupied the greater part of an 18-acre field and provided 4,000 feet of frontage for exhibits. The distribution system required 2,300 feet of three-wire secondary bus, supplying 58 services with a load of approximately 50 kilowatts. The water supply was obtained from the Ontario Hospital farm system and required the laying of 2,600 feet of piping with eight hydrants.

There were 659 entries in the contests, which established an all-time record and reflect the growing interest in the match.

On Thursday, the match was honored by a visit of His Excellency Baron Tweedsmuir of Elsfield, Governor General of Canada, who showed a keen interest in the contests and work of the Association.

One of the most interested visitors to the match was C. F. Rath of Lansdowne, who, although 99 years of age, plowed with the oxen during his visit and took a keen interest in the exhibits of modern farm equipment.

The Hydro-Electric Power Commission trophy consisting of a ½-horsepower motor as first prize in class 7 tractor plowing was won by Spencer Wilson of Norval.

The Hydro-Electric Power Commission Exhibit took the form of an

*Section of Hydro showing household appliances.*

instructive display of representative electrical household and barn equipment. The exhibit was housed in a 40 by 70 ft. tent and was arranged along the two ends and one side. The displays, as the pictures show, consisted of the following pieces of equipment: Hydro flat-rate water heater, ironing machine, washing machines, refrigerators, stoves, rangette, radio, electric motors, soil heating equipment in actual operation, shallow-well pump and deep well pump, grain grinder, poultry water warmer, electric brooder, modern school lighting picture, time switch control for poultry pen lighting, milk cooler, separator and milking machine. The various pieces of equipment had informative signs outlining the nature of the equipment and the approximate operating cost.

There was also a running commentary which was broadcast by means of a record in the form of a three part conversation between a rural representative and a farmer and his wife outlining the benefits derived from the use of the electric equipment shown in the tent, and stressing the saving of time and money that the full use of electric equipment makes for the farmer.

Two display areas were devoted to small appliances and space was also provided for interviewing prospects.

This was the first year that the Hydro Travel Coach has appear-

*Section showing farm equipment.*

*Exhibition and concession area.*

ed at the International Plowing Match, and along with the display in the tent proved to be one of the most interesting exhibits at the show for rural residents.

The complete display was manned by the Hydro-Electric Power Commission and no attempt was made to sell equipment, but rather to inform the farmer just what electrical equipment could do for him. Keen interest was displayed by the rural consumers in the many labor saving devices and the staff was kept extremely busy answering many pointed questions.

*Evolution in farm traction shown at the International Plowing Match.*

# Expansion of Hydro Service in Northern Ontario Mining Districts

By T. C. James, Assistant Engineer,
The Hydro-Electric Power Commission of Ontario

THE Hydro-Electric Power Commission of Ontario has been supplying power for mining purposes in Northern Ontario since 1929. During this ten-year period a phenomenal increase in load growth has taken place, which is indicative of the tremendous expansion in the mining industry in this area. To provide for this load growth, it has been necessary for the Commission constantly to increase generating plant capacity, to construct additional transmission lines, to enlarge existing and construct new transformer stations, and in general, to re-arrange in many instances the entire set-up under which power delivery has been made. In fact, the increase in the power demand from both existing and new mining properties has been so rapid that enormous effort was required on the part of the Commission to provide plant and equipment fast enough to prevent embarrassment to mining operations, from the standpoint of power supply. These facts become more apparent when it is considered that the load growth has approximated 92,000 h.p. during the last three years.

In *The Bulletin* for October, 1936, and in various technical journals at that time, a complete description was given under the title of "Power Supply in Northern Ontario Mining Districts," of the various generating plants, transmission systems and transformer stations which the Commission is using to serve mining properties. At other times also the technical press has carried complete and detailed descriptions of parts of the Commission's systems supplying power to the mining industry. Any repetition of the detailed description of these various systems is therefore unnecessary, as the mining industry is quite familiar with the present set-up.

The accompanying map clearly indicates the extent of the Commission's operations in Northern Ontario covering power supplied from thirteen individual hydro-electric developments, and 1,600 miles of transmission lines utilized to deliver this power to mining customers. Wherever large blocks of power are used 132-110 kv. trunk transmission lines supply energy to terminal stations, 1,000 miles of this type being in operation, and lower voltage transmission distributing lines, of which there are in operation 600 miles originating from these stations, serve individual customers. These lower voltage lines are operated at 22 kv. and 44 kv. in 60-cycle districts, and at 26 kv. and to a limited

extent, at 12 kv., in 25-cycle districts, although the latter voltage is not considered as standard.

In the former article the following table of load growth described conditions up to June, 1936.

that date, a second column has been added showing the loads as of August, 1939, and a third column giving increases established during the intervening period. (See table on next page).

POWER SOLD AND NUMBER OF MINES UNDER CONTRACT

| YEAR | Power sold as at October 31, horsepower | Increase over the previous year, horsepower | Number of mines supplied or under contract | Increase over the previous year |
|---|---|---|---|---|
| 1930 | 10,503 | — | 4 | — |
| 1931 | 25,848 | 15,345 | 5 | 1 |
| 1932 | 25,985 | 137 | 5 | — |
| 1933 | 26,804 | 819 | 4 | 1 (Decrease) |
| 1934 | 44,086 | 17,282 | 9 | 5 |
| 1935 | 55,472 | 11,386 | 19 | 10 |
| 1936* | 65,928 | 10,456 | 30 | 11 |

*To June 30, 1936.

THE FOLLOWING INDICATES LOAD EXPANSION IN MINING POWER SUPPLIED FROM 1936 TO 1939

| YEAR | Power sold as at October 31, horsepower | Increase over the previous year, horsepower | Number of mines supplied or under contract | Increase over the previous year |
|---|---|---|---|---|
| 1936 | 77,025 | 21,553 | 30 | 11 |
| 1937 | 117,341 | 40,316 | 40 | 10 |
| 1938 | 137,029 | 19,688 | 48 | 8 |
| 1939* | 158,053 | 21,024 | 54 | 6 |

*To August, 1939.

The difference in 1936 conditions in these two tabulations represents changes between June 30, and October 31.

The following tabulation sets out the customers served in June, 1936, with loads taken by each during that month. This information was also published in the former article to serve as a comparison of the load expansion of these customers, as well as to indicate new properties served since

Up to and including June, 1936, thirty mining contracts had been executed by the Commission covering power supply for mining purposes in the Northern Ontario area, three of which at that time had not become active. Out of the twenty-seven active contracts nineteen covered producing mines and eight were for mines still in the development stage. The load taken for mining purposes approximated 66,000 h.p.

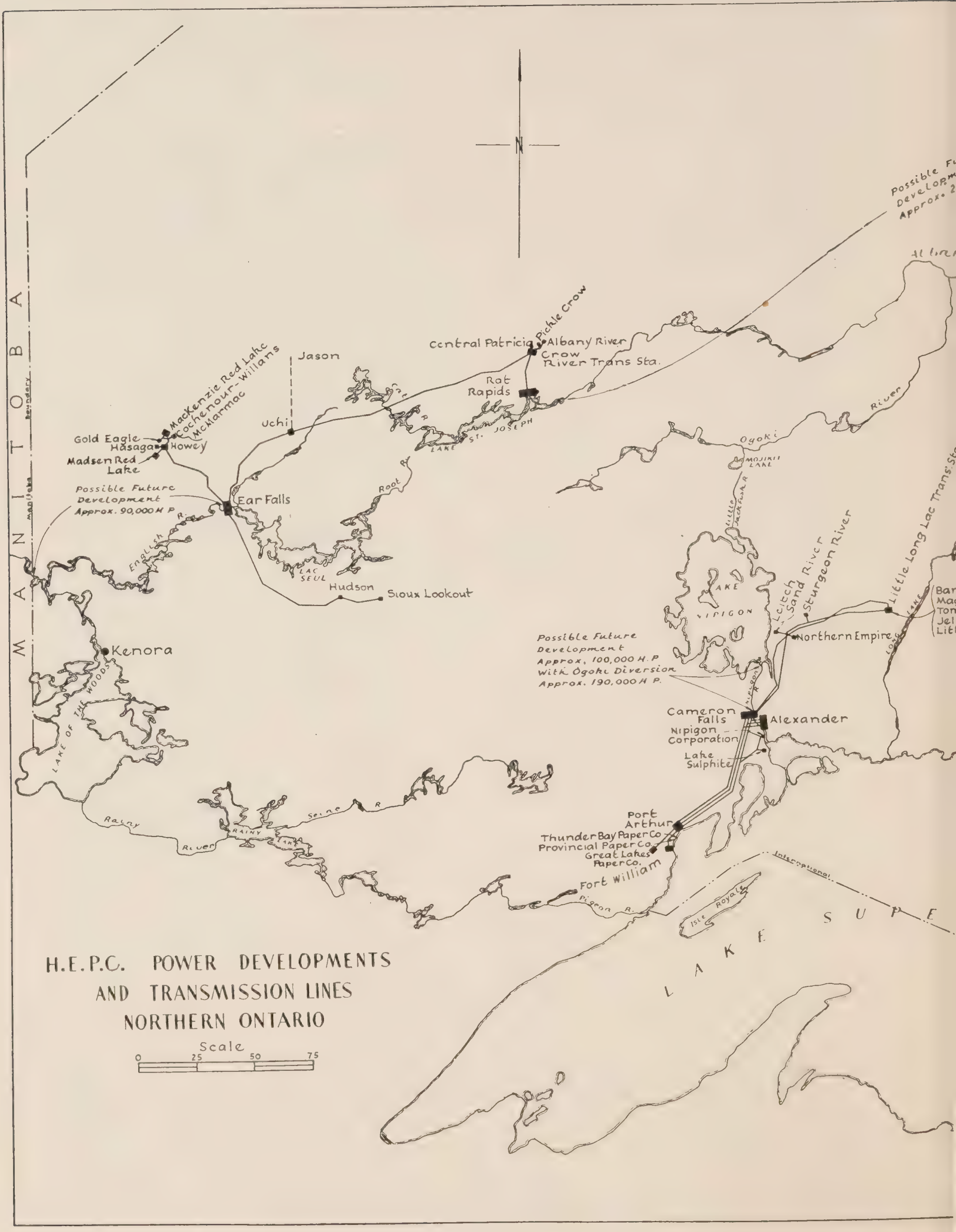
Customers Served in the Mining Districts of Northern Ontario

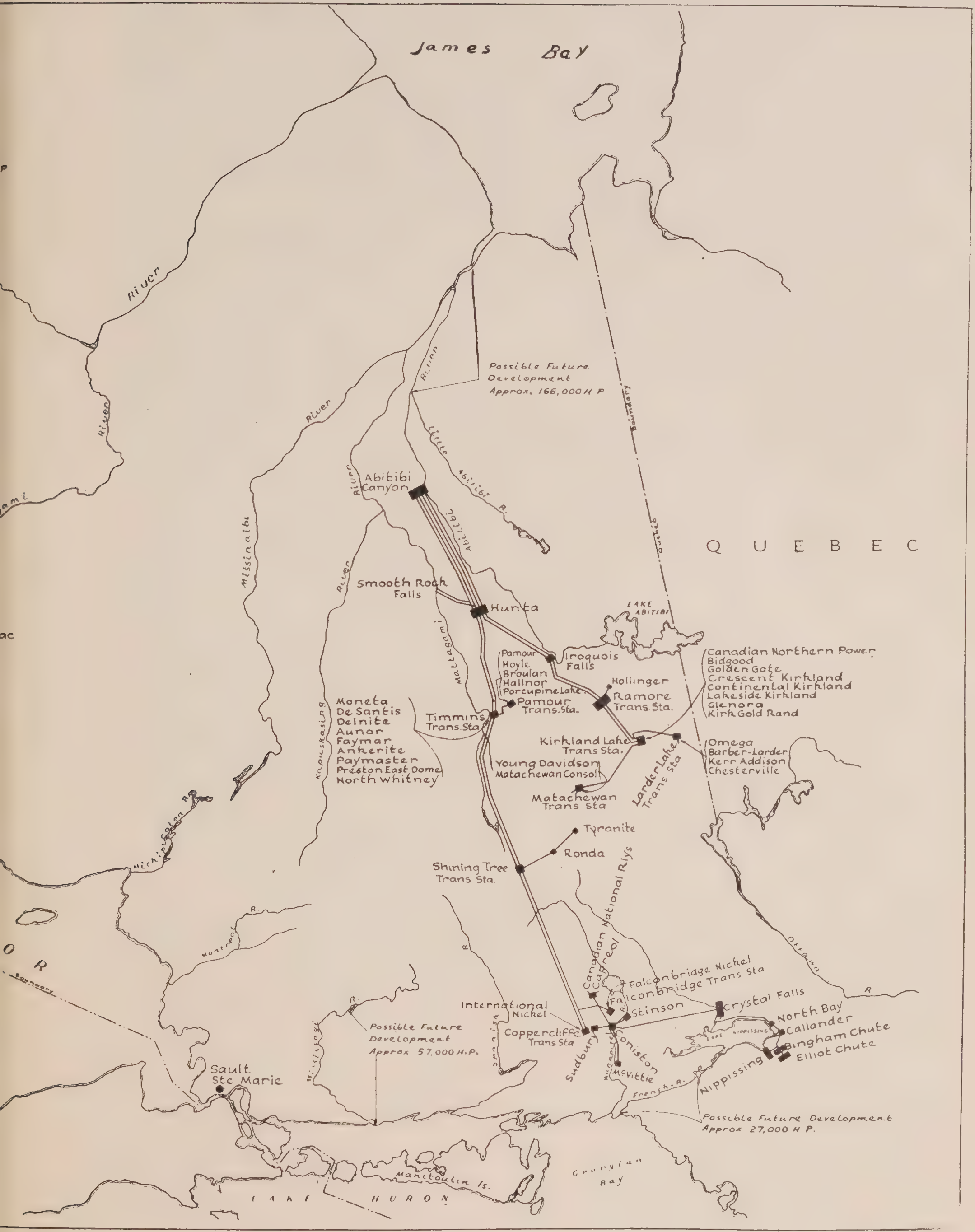
| Customer | Load in horsepower | | |
|---|---|---|---|
| | June 1936 | August 1939 | Increase |
| **Abitibi District** | | | |
| Bidgood Kirkland | 764 | 1,370.9 | 606.9 |
| Central Porcupine | 260 | — | −260 |
| Falconbridge Nickel | 1,299.2 | 2,994.9 | 695.7 |
| Glenora Gold | 176.8 | — | −176.8 |
| Hollinger Consolidated (Ross Mine-Hislop Twp.) | 609.9 | 929.3 | 319.4 |
| Hollinger Consolidated (Young-Davidson) | 1,769.4 | 2,636.9 | 867.5 |
| Huronian Company (Inter. Nickel)—Smelter | 14,658 | 36,572 | 21,914 |
| Huronian Company (Inter. Nickel)—Refinery | 4,933 | 12,395.7 | 7,462.7 |
| Matachewan Consolidated | 571 | 1,191 | 620 |
| Moffatt-Hall | 150 | — | −150 |
| Canada Northern Power Corp'n | 20,093.8 | 45,777.5 | 25,683.7 |
| Omega | 1,081.2 | 1,598.9 | 517.7 |
| Pamour Porcupine | 1,764 | 3,809.1 | 2,045.1 |
| Paymaster Consolidated | 1,673 | 2,535.9 | 862.9 |
| Vimy | 150 | — | −150 |
| McMillan | 197.8 | — | −197.8 |
| Aunor | — | 446.4 | 446.4 |
| Kerr Addison | — | 1,565.8 | 1,565.8 |
| Barber Larder | — | 25.5 | 25.5 |
| Lakeside Kirkland | — | — | — |
| Broulan Porcupine | — | 216.6 | 216.6 |
| Mace | — | 676.4 | 676.4 |
| Buffalo Ankerite | — | 3,631.6 | 3,631.6 |
| Moneta Porcupine | — | 924.4 | 924.4 |
| Chesterville Larder Lake | — | 1,354.4 | 1,354.4 |
| Porcupine Lake Gold | — | 5.4 | 5.4 |
| Delnite | — | 995.7 | 995.7 |
| Preston East Dome | — | 1,097.8 | 1,097.8 |
| DeSantis Porcupine | — | 516.7 | 516.7 |
| Ronda | — | 243.4 | 243.4 |
| Faymar Porcupine | — | 294 | 294 |
| Denison Nickel | — | 154.2 | 154.2 |
| Golden Gate | — | 405.6 | 405.6 |
| Tyranite | — | 701.7 | 701.7 |
| Hallnor | — | 1,418.2 | 1,418.2 |
| Hoyle | — | 374.5 | 374.5 |
| Kir-Vit | — | — | — |

| Customer | Load in horsepower | | |
|---|---|---|---|
| | June 1936 | August 1939 | Increase |
| **Patricia & St. Joseph Districts** | | | |
| Gold Eagle | — | 647.2 | 647.2 |
| Howey | 2,781.5 | 2,763.4 | −18.1 |
| Madsen Red Lake | — | 1,365.9 | 1,365.9 |
| McKenzie Red Lake | 607.2 | 886. | 278.8 |
| Red Lake Gold Shore | 220.3 | — | — |
| Hasaga | — | 822.5 | 602.2 |
| Skookum | — | — | — |
| Uchi | — | 1,931.6 | 1,931.6 |
| Cochenour Willans | — | 212.2 | 212.2 |
| Central Patricia | 665 | 1,375.3 | 710.3 |
| Pickle Crow | 630 | 1,616.6 | 986.6 |
| **Sudbury District** | | | |
| Falconbridge Nickel | 3,868.6 | 4,748.9 | 880.3 |
| Huronian Co. (International Nickel) | 4,161 | 4,161 | — |
| **Thunder Bay System** | | | |
| Leitch Gold | 150 | 601.9 | 451.9 |
| Little Long Lac | 1,655.6 | 2,198.1 | 542.5 |
| Northern Empire | 883.3 | 1,164.9 | 281.6 |
| Sand River | 150 | 557.9 | 407.9 |
| Sturgeon River Gold | — | 552.5 | 552.5 |
| Bankfield Consolidated | — | 931.6 | 931.6 |
| Hard Rock | — | 1,345.5 | 1,345.5 |
| Jellicoe Consolidated | — | 219.7 | 219.7 |
| Tombill | — | 492.9 | 492.9 |
| MacLeod-Cockshutt | — | 2,154.5 | 2,154.5 |
| Magnet Consolidated | — | 442.8 | 442.8 |
| Totals | 65,923.6 | 158,053.3 | 92,129.7 |

*Note:* Minus sign indicates *decrease.*

The growth and expansion in the mining industry in Northern Ontario and the load growth with respect to power supply by the Commission for that purpose presents a remarkable picture when comparing the conditions which prevailed in June, 1936, with conditions obtaining as of August, 1939. During that three-year period thirty additional mining contracts were executed by the Commission, making a total of sixty executed contracts up to the latter date. Out of this number fifty-four contracts are


H.E.P.C. POWER DEVELOPMENTS
AND TRANSMISSION LINES
NORTHERN ONTARIO
Scale
0 25 50 75
MANITOBA
Manitoba Boundary
Jason
Uchi
Central Patricia
Pickle Crow
Albany River
Crow River Trans Sta.
Rat Rapids
Lake St. Joseph
MacKenzie Red Lake
Cochenour-Willans
McMarmac
Gold Eagle
Hasaga
Howey
Madsen Red Lake
Possible Future Development Approx. 90,000 H.P.
Ear Falls
English R.
Root R.
Lac Seul
Hudson
Sioux Lookout
Kenora
Lake of the Woods
Rainy River
Rainy Lake
Seine R.
Ogoki River
Mojikit Lake
Little Jackfish R.
Lake Nipigon
Leitch
Sand River
Sturgeon River
Northern Empire
Little Long Lac Trans. Sta.
Long Lake
Possible Future Development Approx. 100,000 H.P. With Ogoki Diversion Approx. 190,000 H.P.
Cameron Falls
Alexander
Nipigon Corporation
Lake Sulphite
Port Arthur
Thunder Bay Paper Co.
Provincial Paper Co.
Great Lakes Paper Co.
Fort William
Pigeon R.
International
Isle Royale
LAKE SUPE


James Bay
QUEBEC
Possible Future Development Approx. 166,000 H P
Abitibi Canyon
Smooth Rock Falls
Hunta
Lake Abitibi
Iroquois Falls
Pamour
Hoyle
Broulan
Hallnor
Porcupine Lake
Pamour Trans. Sta.
Hollinger
Ramore Trans. Sta.
Timmins Trans. Sta
Moneta
De Santis
Delnite
Aunor
Faymar
Ankerite
Paymaster
Preston East Dome
North Whitney
Canadian Northern Power
Bidgood
Golden Gate
Crescent Kirkland
Continental Kirkland
Lakeside Kirkland
Glenora
Kirk Gold Rand
Kirkland Lake Trans Sta.
Larder Lake Trans Sta
Omega
Barber-Larder
Kerr Addison
Chesterville
Young Davidson
Matachewan Consol
Matachewan Trans Sta
Tyranite
Ronda
Shining Tree Trans Sta.
Canadian National Rlys
Capreol
Falconbridge Nickel
Falconbridge Trans Sta
Stinson
Crystal Falls
North Bay
Callander
Bingham Chute
Elliot Chute
Nippissing
International Nickel
Coppercliffe Trans Sta
Sudbury
Coniston
McVittie
French R.
Possible Future Development Approx 27,000 H P.
Possible Future Development Approx 57,000 H.P.
Sault Ste Marie
Manitoulin Is.
Georgian Bay
Lake Huron
Little Abitibi R.
Abitibi
Mattagami
Missinaibi
Kapuskasing
River
Boundary
Ottawa R
Montreal R.

active; the inactive contracts represent power supply for six mining properties which have discontinued operations either permanently, or temporarily owing to insufficient ore bodies or difficulties in financing. Out of the fifty-four active contracts, forty-four represent power supply for producing mines, and ten cover the operations of mining properties still in the development stage. The load sold during this three-year period has reached a maximum exceeding 158,000 h.p., a growth of 92,000 h.p., or an increase of approximately 140 per cent.

In the Porcupine, Kirkland Lake and adjacent camps served by the Abitibi Canyon development the sixteen active contracts in June, 1936, had increased to thirty-six active contracts by August, 1939. In the Red Lake, Woman Lake, and Pickle Lake mining areas served by the Ear Falls and Rat Rapids developments during the same period the increase was from five to eleven contracts, with nine active, eight of which were producing mines, and one being a property with a mill under construction ready to go into production before the close of 1939.

In the Little Long Lac and Beardmore areas served by the Nipigon developments, where two producing mines and two mines in the development stage were served in June, 1936, the total number of contracts in August, 1939, had increased to eleven, with ten mines under production and one mine in the development stage.

As an illustration of the changes required in plant and equipment, and in new work necessary to be undertaken by the Commission to provide for the load growth in power supplied to the Northern Ontario mining industry, the following résumé applies to what has been accomplished in this respect, as well as setting out work under construction, or about to be undertaken.

In the Sudbury district, where 60-cycle power is supplied from three developments on the Wanapitei river, the Crystal Falls development on the Sturgeon river with a capacity of approximately 10,000 h.p. was acquired from the Abitibi Power & Paper Co. in 1937, and forty-six miles of 44 kv. transmission line was constructed between this plant and the Coniston development on the Wanapitei river, thus increasing the generating plant capacity in the Sudbury district by the output of this development. As the Crystal Falls development was already connected to the three developments on the South river serving North Bay and the vicinity, in the Nipissing district, the acquisition of this plant and the construction of the tie line to the Wanapitei developments gave the Commission a chain of seven hydro-electric plants having a normal combined capacity of 31,500 h.p. interconnected through transmission lines extending from Sudbury to North Bay. Power is supplied at the present time from this network at 60 cycles to the International and Falconbridge nickel mines. A new concrete dam was constructed at the Coniston development in 1938 replacing the old structure, for the purpose of increasing the stability of the generating plant, and during 1939 the forty-six miles of 44 kv. line from the Crystal

Falls development to Coniston was changed for 110 kv. operation.

In the Espanola district approximately twenty-four miles of 33 kv. transmission line was constructed in the spring of 1938 and placed in operation. This line runs between the Espanola development at Espanola and the Denison nickel mine, power being purchased by the Commission from the Abitibi Co. at Espanola for the purpose of serving this customer.

In the Abitibi district, which includes the mining camps in the Porcupine, Kirkland Lake, Ramore, Larder Lake, Matachewan, and part of Sudbury mining areas, a new 4,500 kv-a. terminal station was constructed at Pamour, together with eight miles of new 132 kv. transmission line. This equipment was placed in operation in December, 1936. To serve new customers who had contracted for power supply, approximately eighteen miles of new 26 kv. branch transmission lines were constructed and placed in operation during 1937, four and a half miles in 1938, and thirty-eight miles to date in 1939. Included in the latter is a loop line out of the Timmins transformer station to give customers in that area the advantage of being served from two sources with respect to transmission line facilities, each side of the loop line being constructed in a different location and being several miles apart. Should a fault occur in either branch of this loop line, service could be supplied to customers from the other side of the loop. The Timmins terminal station was doubled in capacity, that is, increased from 4,500 to 9,000 kv-a. and the new equipment placed in operation in October, 1937. At the present time, the Timmins station is being reconstructed by replacing the existing six 1,500 kv-a. transformers with three 5,000 kv-a. transformers. This new station is expected to be ready for service before the close of 1939. Three of the 1,500 kv-a. transformers released from Timmins will be installed at the Ramore station and utilized to increase the capacity, from 1,000 to 4,500 kv-a. The remaining three 1,500 kv-a. transformers will be installed at the Larder Lake transformer station to double its capacity and three new 1,500 kv-a. transformers will be installed at the Pamour station, to double its capacity.

A fourth bank of three 16,000 kv-a. transformers was added to the equipment at the Abitibi Canyon development in March, 1938, thus providing transformation equipment for 240,000 h.p. In the spring of 1939 a new 1,000 kv-a. terminal transformer station was constructed at Westree to supply power to the Ronda and Tyranite mines. During 1939 a new bank of three 9,500 kv-a. transformers was installed, and placed in operation at the Kirkland Lake transformer station, together with 15,000 kv-a. in voltage regulating equipment, increasing the capacity from 28,500 to 57,000 kv-a.

In the Thunder Bay district, including the areas of Beardmore and Little Long Lac served from the developments on the Nipigon river, all of the branch lines originally constructed by customers were purchased by the Commission, and merged into its own transmission network. This involved the taking over of approximately one hundred miles of 44 kv. transmission lines. At the same time a new 110

kv. trunk transmission line was constructed from Cameron Falls to Little Long Lac, a distance of approximately ninety-three miles, and a new 9,000 kv-a. transformer station was constructed at the Little Long Lac terminus. This station and line was placed in operation in January, 1938.

In the Patricia and St. Joseph districts which include the mining areas at Red Lake, Woman Lake and Pickle Lake, many major changes have taken place during the last three years, including the construction and placing in operation of additional generating plant equipment, transmission lines and transformer stations. A second unit at the Ear Falls development was installed and placed in operation during the summer of 1936, increasing the installed plant capacity from 5,000 to 10,000 h.p. During the fall of 1938 construction work was started on the installation of a third unit at Ear Falls, which will have a capacity of 7,500 h.p. It is expected that this additional plant will be in operation by the end of 1939, increasing the Ear Falls installed capacity to 17,500 h.p. Excavation work has been started on the installation of a fourth unit at Ear Falls, having the same capacity as the third unit. This fourth unit can be made available for service by the end of 1940 and when placed in operation will bring the Ear Falls development to its ultimate installed capacity of 25,000 h.p.

A new 44 kv. transmission line approximately forty-eight miles in length was constructed between Ear Falls and the Uchi mine in the Woman Lake district. This line was placed in operation in May, 1939. A new transmission line one hundred and thirteen miles in length was erected between the Uchi mine and Crow River near the Central Patricia mine and a 3,750 kv-a. transformer station was constructed at the Crow River terminus. This transmission line connects the Ear Falls development on the English river with the Rat Rapids development on the Albany river, thus amalgamating the two developments into one system. The line, although insulated for 66 kv., will first be operated at 44 kv. The change to the higher voltage will be made as soon as load conditions warrant. This line and equipment at Crow River was placed in operation on September 4, 1939.

The construction of a thirty-three mile transmission line from the Uchi to the Jason mine was started in the spring of 1939, the line to be ready for operation early in 1940. The Howey transmission line was purchased by the Commission in the spring of 1938, and since that date all of the transmission lines in the Red Lake area owned by individual mining companies have been purchased by the Commission, thus giving the Commission ownership of all transmission lines originating out of the Ear Falls generating plant. This transaction involved the acquisition of thirteen miles of 44 kv. transmission line.

In the article which appeared in *The Bulletin* of October, 1936, reference was made to the undeveloped water power sites scattered throughout the northern part of the Province which are available for utilization by the Commission to develop additional

supplies of power for mining and other purposes. It is now evident that in the near future some of these power sites must be developed to keep pace with the increasing demands of the mining industry.

The Commission from time to time has placed survey parties in the field collecting information respecting these sites and much detailed information is already available. It takes, however, two or three years to plan for and to construct additional power developments of small size, and longer periods for large plants, nevertheless, the mining industries need fear no power shortage providing the individual mines co-operate with the Commission by giving ample notice of their probable power requirements.

# Drying Out Flooded Electrical Machinery

By Engineers of the Operating Department, H.E.P.C. of Ontario

*(Continued from September)*

## 2. Vacuum Drying Method

The hot air and internal heat method previously described is a positive method but it is slow. The vacuum method described in the remainder of this article is a much quicker way in which to dry flooded equipment but, due to the nature of the apparatus required, it may be a more expensive proposition.

The method used for large units resolves itself into a problem of economics. The special vacuum tank for a single machine will most likely cost more than an air drying assembly. On the other hand, if the equipment is urgently required or a loss of revenue is involved, it may be more economical to use the vacuum tank and thereby materially shorten the drying time. Where there are a number of similar machines to be dried and their design permits the use of the same

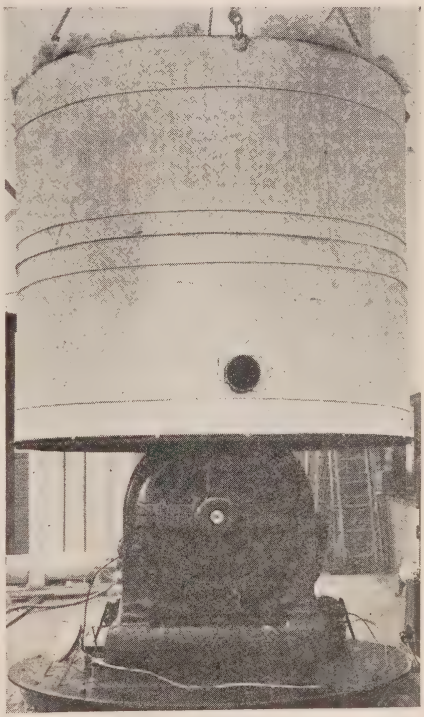


*Fig. 5—Vacuum tank for drying small apparatus.*

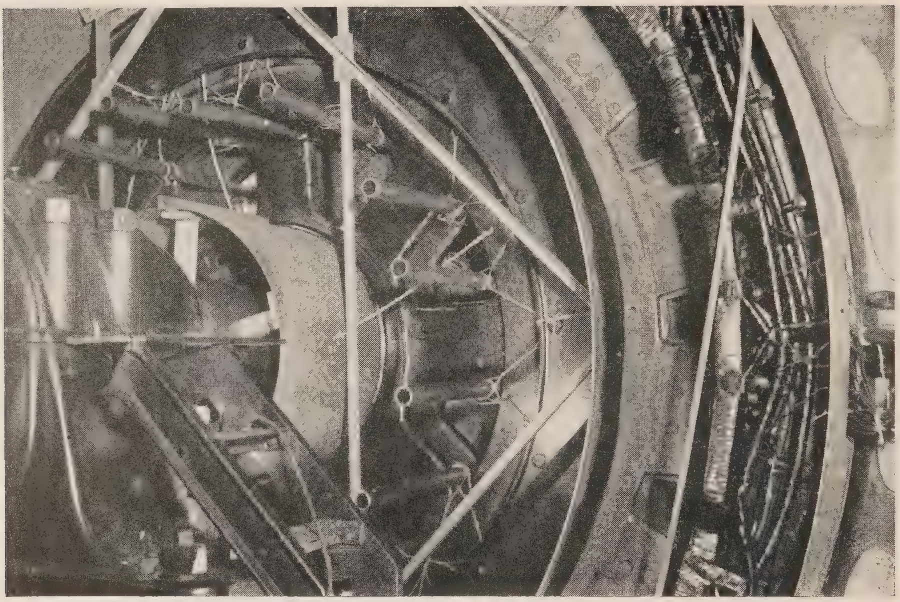


*Fig. 6.—Internal bracing for end plates forming part of the vacuum chamber.*

vacuum equipment on each of them, it may prove cheaper to dry under vacuum method than by means of hot air alone.

Experience indicates that drying under vacuum may be accomplished in days as compared with months by hot air drying. Therefore, if time is a valuable element, the vacuum process may be used to advantage.

Where there is a large number of small machines to be dried and a medium-sized vacuum tank can be constructed at relatively low cost, the vacuum process is unquestionably a cheaper, quicker and more reliable method of meeting this problem than any other method developed so far.

*Principle*

The principle underlying the vacuum method involves boiling points and pressures. Firstly, the moisture is removed more rapidly because of the increased rate of evaporation at the lower pressure. Secondly, the moisture has an added urge to move outward through the insulation, due to the lower surrounding pressure. These two factors account for the much increased drying rate.

*Vacuum Tank*

In order to place the machine under vacuum, it is, of course, necessary to enclose it in an air-tight tank. For small machines, large oil drums or water tanks serve the purpose very well. It would be prudent, however, to calculate the stresses to be imposed upon such a tank before applying a vacuum, since some internal bracing might be required. Fig. 5 shows such a tank.

Machined flanges on covers are not essential. A very effective seal can be made using rough flanges and ½-in. plain round rubber or ½-in. cor-

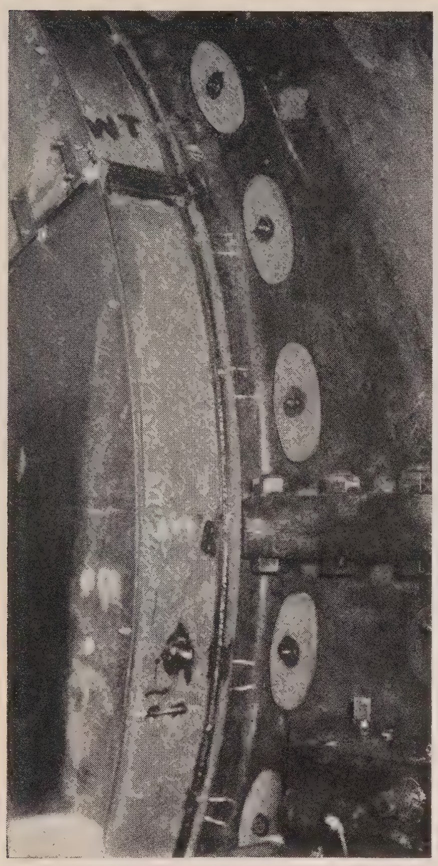


*Fig. 7—Sealed ventilating ports.*

rugated garden hose as a gasket. A piece of round solid rubber of appropriate diameter should be pulled through the hose to prevent it from cracking when bolted between the flanges. To fill any small cracks, caulking compound covered with a few layers of friction tape and painted with glyptal serves very well. The tape is necessary since the caulking compound, when used alone, will be forced through the crack upon the application of a vacuum.

Large machines present a different problem in so far as tank construction is concerned. The illustrations, Figs. 6, 7, 8, 9, and 9A, show how this problem was solved for the 9,000 kw. machines at the Ontario Power generating station. The machine frame itself was used as part of the vacuum tank, as can be seen in the illustration. End covers of ½-in. boiler plates were made in three segments for ease of handling. As in the case of small vacuum tanks, garden hose was used to seal the edges of these plates. Cast iron oval-shaped discs fitted with 1-in. square rubber gaskets were used to cover the ventilation ports, (see Fig. 7). Internal bracing in the form of boiler plate hubs and pipe bracing was necessary to prevent the plates from buckling under vacuum. (See Fig. 6). Inasmuch as machines differ in structural details the design of vacuum tanks must take account of these differences.

Leak-proof bushings must be inserted in the wall of the tank to provide for the installation of thermocouple and current leads. Two pipe stubs must be welded in place, one for the vacuum pump connection, the other for a vacuum control valve which opens to the atmosphere.

Since vacuum pumps are not readily available pieces of equipment, an air compressor may be used and it will serve the purpose very well. The air intake side of the compressor is connected to the vacuum chamber, sucking air from the chamber and discharging it at atmospheric pressure. Provided that the vacuum chamber has been properly sealed, vacuums as high as 26 to 28 inches of mercury are easily obtained.

A condenser and trap must be in-

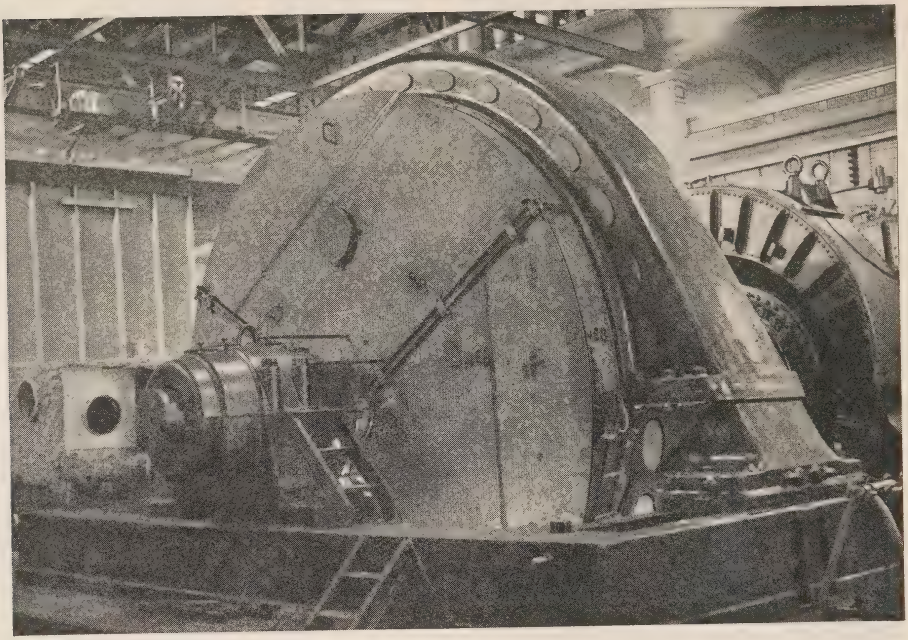


*Fig. 8—The hermetically sealed machine.*

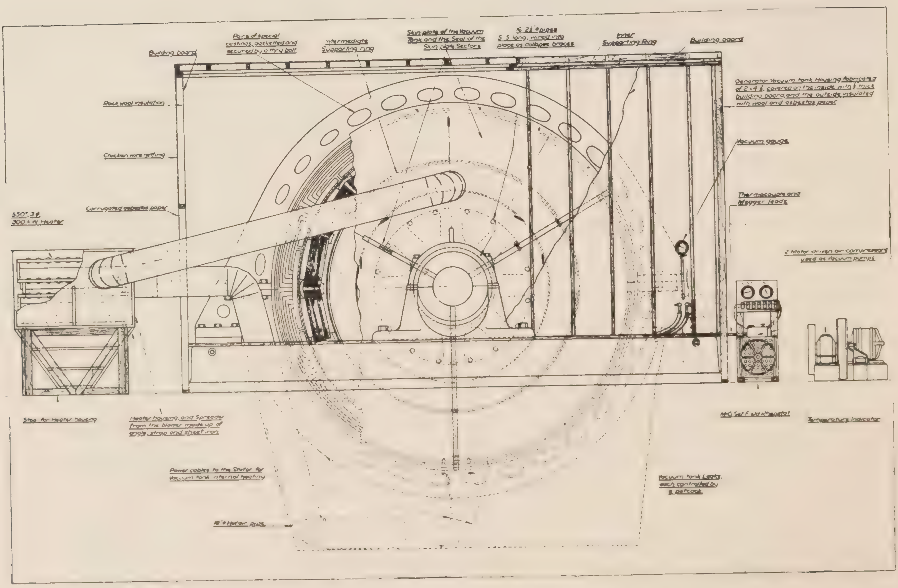



*Fig. 9—Details—Vacuum chamber and drying enclosure—End View.*

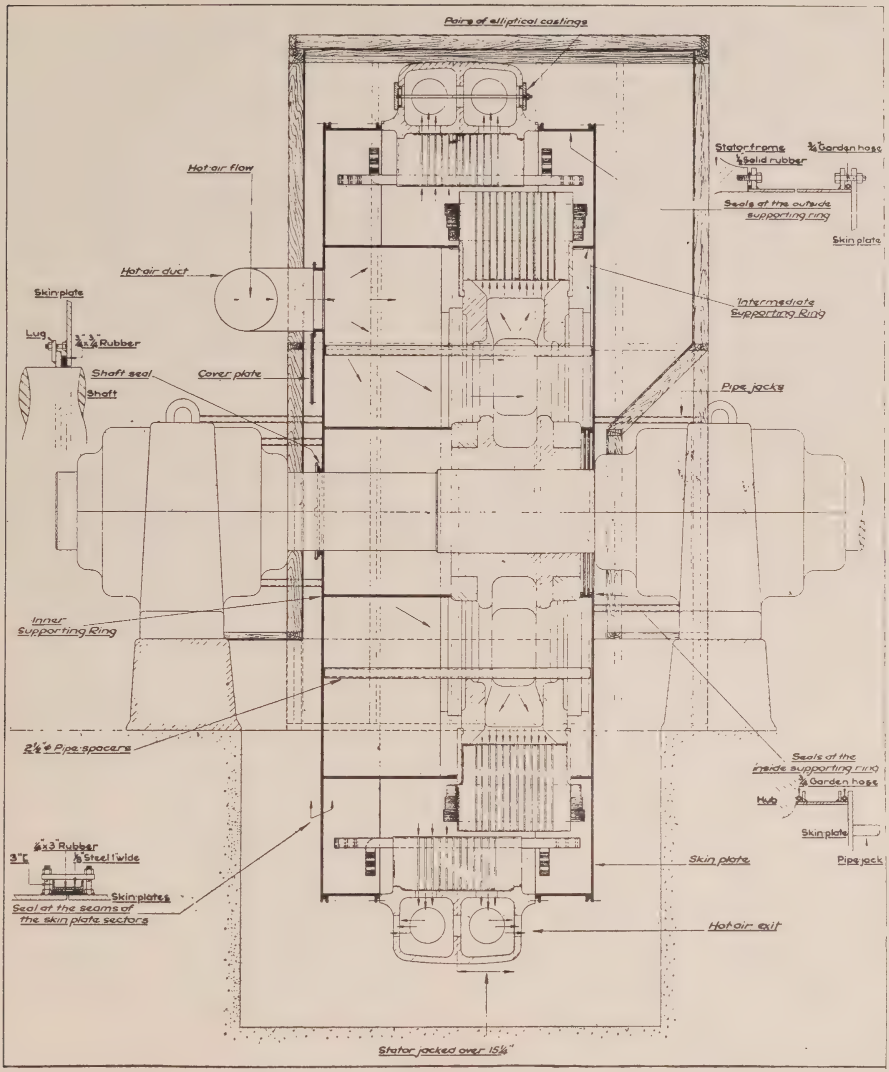



*Fig. 9a—Details—Vacuum chamber and drying enclosure—Side View.*

stalled in the suction line to prevent water entering the compressor. Provision should be made to collect and measure the condensate, so that the hour-by-hour quantity of water removed from the machine may be determined.

Although it requires less heat to evaporate moisture at lower pressures, more of the applied heat will be absorbed per unit of time due to the rapid rate of evaporation. Thus, insulation is necessary to reduce radiation losses from the tank. For small tanks this may be provided by binding rock wool around the sides and

ends, whereas for large tanks of irregular shapes a frame enclosure built in sections may be quickly and easily assembled over the complete machine. A separate air heater can then be used to heat the enclosure and keep the vacuum tank at a high temperature.

*Drying Procedure*

In the process of drying under vacuum, care must be taken not to produce such an evaporation rate that pockets of steam are formed in the insulation. Should this occur, the insulation might easily be ruptured. Before applying any vacuum whatsoever, the machine temperature as a whole should be raised to a value determined by the quantity of insulation used on the windings.

The means of obtaining high temperatures and controlling them may be effected in these ways:—

1. For small tanks, by placing small electric heaters inside the tank.

2. For large tanks, by blowing hot air into an air-tight supplementary chamber containing the vacuum tank, much in the same manner as in the hot air drying scheme.

3. By internal heat means. Since the rotor must remain stationary, the armature windings should be connected in series and supplied with direct current from a controlled source. This is by far the best method.

When the whole machine has come to a steady temperature the pumps should be started with the vacuum control valve wide open and the vacuum applied gradually. In building up the vacuum care must be taken to avoid excessive steaming in the coils. A slow rate of evacuation, about 1 in. mercury every fifteen minutes, is essential in establishing the vacuum.

As the vacuum increases the moisture will leave the coils in the form of low pressure steam. The machine temperature may fall due to the rapid rate of evaporation and necessitate an increase in stator or armature currents. The vacuum should be increased slowly until the maximum possible has been attained. It should be held there until the machine has been thoroughly dried.

Megger tests of the insulation should be made and recorded at regular intervals from the commencement of drying. As long as the insulation resistance at any chosen measured temperature continues to rise, the moisture is still moving in the coils. The machine is dry only when the curve of insulation resistance against time flattens out. The vacuum may then be gradually reduced to zero and the machine allowed to cool.

During the cooling period the insulation resistance temperature curve should be obtained. This serves as a check upon the condition of the windings.

Finally, as in the case of the hot air drying system, the coil ends must be reinsulated, the windings painted and a high voltage test applied.

# Series Lamp Operation

By H. F. Davidson, Photometric Laboratory, H.E.P.C. of Ontario

IN recent months the writer has come in contact with several views as to what constitutes good series lamp performance. With this in mind the following article has been written with the hope that users of series lamps will obtain a better understanding of their operation and thereby derive optimum service.

### MOST ECONOMICAL LIFE

The production of light by tungsten lamps is the result of heating the filament to incandescence. As the temperature is raised, the life of the lamp is decreased and the efficiency is increased. The decrease in life is due to the greater rate of evaporation of the filament at higher temperatures. Lamps can therefore be made having a long life with low efficiency or a short life with high efficiency. Long-life lamps require fewer replacements than short-life lamps but also produce less light per watt. The problem of finding the most economical lamp life for series street lighting service is then reduced to determining the point between the extremes of long and short life where the advantages and disadvantages will be balanced. The most important considerations are the costs of lamps, energy and labour required to replace lamps. The desirable life varies directly with the cost of lamps and labour for replacements and inversely with the cost of energy. As energy and labour costs vary throughout the province, average values are taken which will represent the province as a whole. This method is quite satisfactory as the variations in desirable life would be too small to justify special lamps for each municipality. At the present time the design life of Hydro Lamps is 2,500 hours which is based on existing average conditions throughout the province for series street lighting service.

The life and efficiency of a lamp bear a definite inverse relation to each other so that the efficiency is automatically decided when the desired life has been obtained. The efficiency of a lamp is expressed in lumens per watt, the lumen being the unit of light.

### LAMP MORTALITY

The life of incandescent lamps can be compared to human life where statisticians can estimate the average life of a group of persons in normal health, but not of any individual person. In a like manner, knowing the quality and operating conditions of a group of lamps it is a simple matter to predict the average life but not the life of any one lamp. This inherent property of tungsten lamps is due to the fact that there are many factors both in manufacture and service that vitally affect life.

Experience in manufacture and constant testing enable the production of lamps having group averages very close to their rating. For a large group of series lamps, approximately 50 per cent will burn out at various intervals up to rated life, the remainder burning out at various intervals

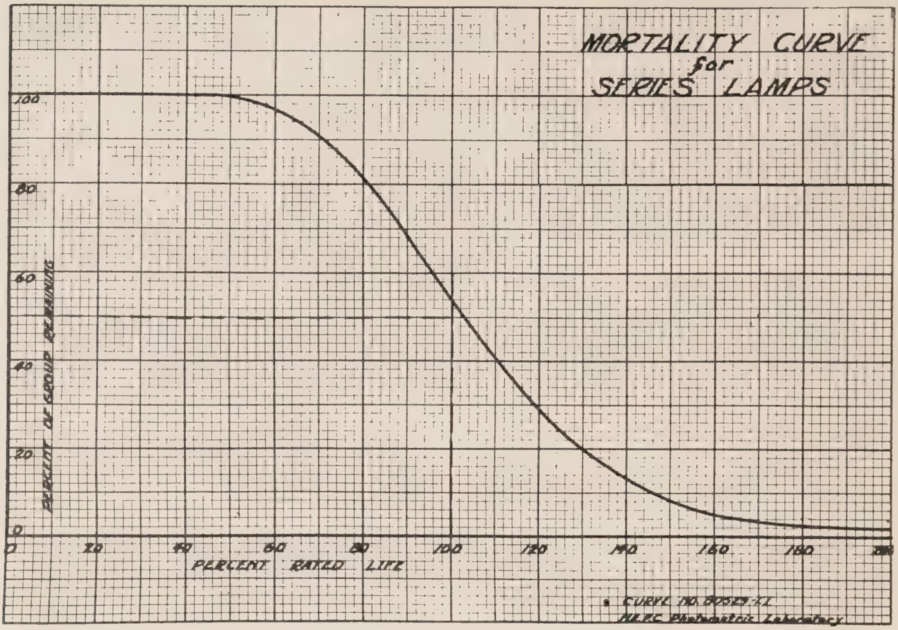



*Fig. 1*

after rated life. The average life of the group will approximate the rated value. This is illustrated by the mortality curve shown in Fig. 1. The curve shows the percentage of the group still burning at various intervals during life. The results shown are for a group of 250 Hydro, 1,000 lumen, 6.6 ampere series lamps. Note that after 2,500 hours burning there was approximately 54 per cent of the group still operating. The average life of the group was 2,740 hours.

### Lamp Renewal Rate

Due to the variation in lamp life, the number of lamps renewed per week or month may vary considerably. Fig. 2, shows the rate of burnout of an original installation of lamps. The number of burnouts is relatively large at about 2,500 hours (rated life). By combining the curves of the lamps renewed with that of the original installation, a curve similar to that shown in Fig. 3 will be obtained. This curve shows the periodic fluctuation in the rate of renewals. Fluctuations are evident for several years following an original installation or abnormal operating conditions. Under proper conditions the renewal rate will vary above and below normal in gradually lesser amounts until it approaches a constant value.

The average number of burning hours for street lighting per year has been found to be 4,000. If lamps having a rated life of 2,500 hours are used, the number of replacements per socket per year will be 1.6. The number of lamps replaced per year will then be 1.6 times the number of sockets. The variation in the lives of the lamps will result in more burnouts

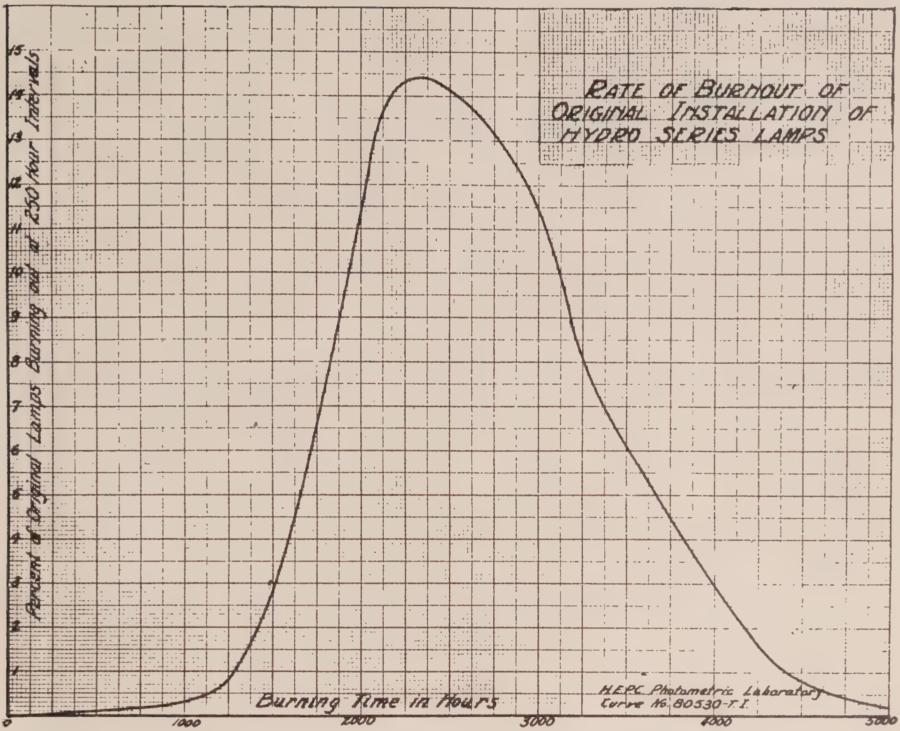



*Fig. 2*

in some sockets than in others but, under good operating conditions, this should not affect the normal number of replacements per year.

SERIES LAMP CHARACTERISTICS

A study of the characteristic curves for series lamps in Fig. 4 will point out the necessity for maintaining normal operating conditions. The curves show the effect on life, lumens, watts, volts and lumens-per-watt of small variations in current. These curves are characteristic only, the actual values depending on the filament temperature at rated current. There is, however, very little deviation from the characteristic trend for different sizes of lamps. At rated current the filament temperature is higher in the larger lamps which accounts for the higher efficiencies obtained.

A given percentage change in current in a series circuit is approximately equivalent to double the variation in voltage in a multiple circuit. It is therefore extremely important that the series circuit be closely regulated. A constant current transformer accurately adjusted and in good working order will give good regulation in addition to providing almost perfect protection for the lamps. Practically the only disturbances likely to cause premature lamp failures are lightning and swinging grounds. Swinging grounds are caused by the wires or fixture loops grounding

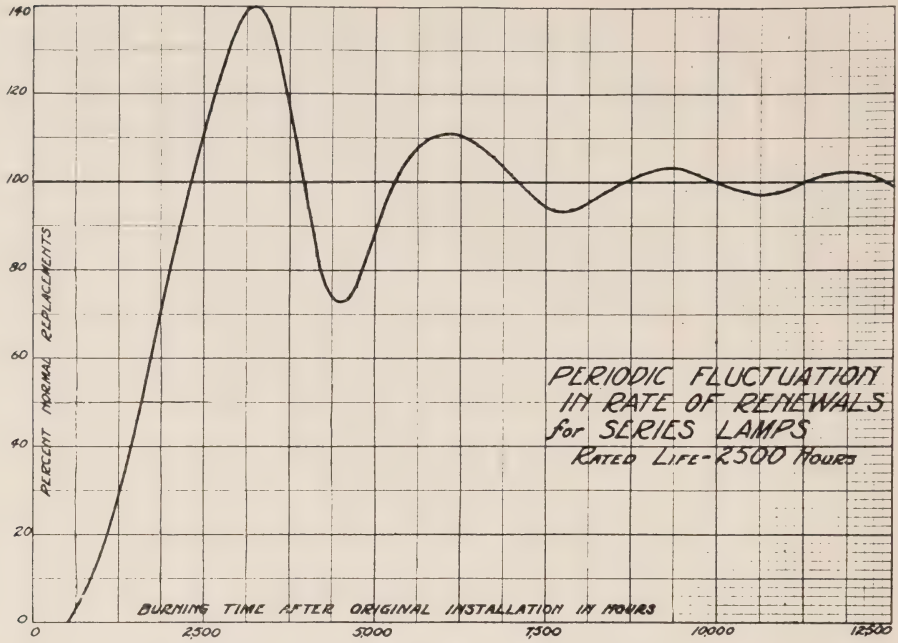



*Fig. 3*

on trees or poles when blown by the wind and give rise to "pumping" in the transformer. The "pumping" action causes current surges which may be sufficient to melt the filaments. Occasionally the moving coil of a constant current transformer does not operate freely and may require an appreciable change in primary voltage to move it, the outcome of which will be a sustained high or low value of current for long periods.

## Life Performance Characteristics

Lamps on constant current series circuits do not have the same life performance characteristics as those on constant voltage multiple circuits. Due to evaporation of the filament, series lamps increase in resistance during life causing an increase in wattage owing to the current being maintained constant. This increase in wattage results in a higher filament temperature and therefore an increase in lumens. On a multiple circuit the watts and lumens decrease during life. In both series and multiple lamps the evaporation of the filament leaves a black or brown deposit of fine tungsten particles on the bulb which causes a decrease in lumens. The lumen maintenance of series lamps is dependent on the difference between the increase in lumens given by the filament and the absorption due to the bulb blackening and is much better on series than on multiple circuits. See Fig. 5.

The increase in volts and watts on series circuits is in the neighbourhood of 4 per cent above the initial value after the lamps have burned their rated life. This increase in

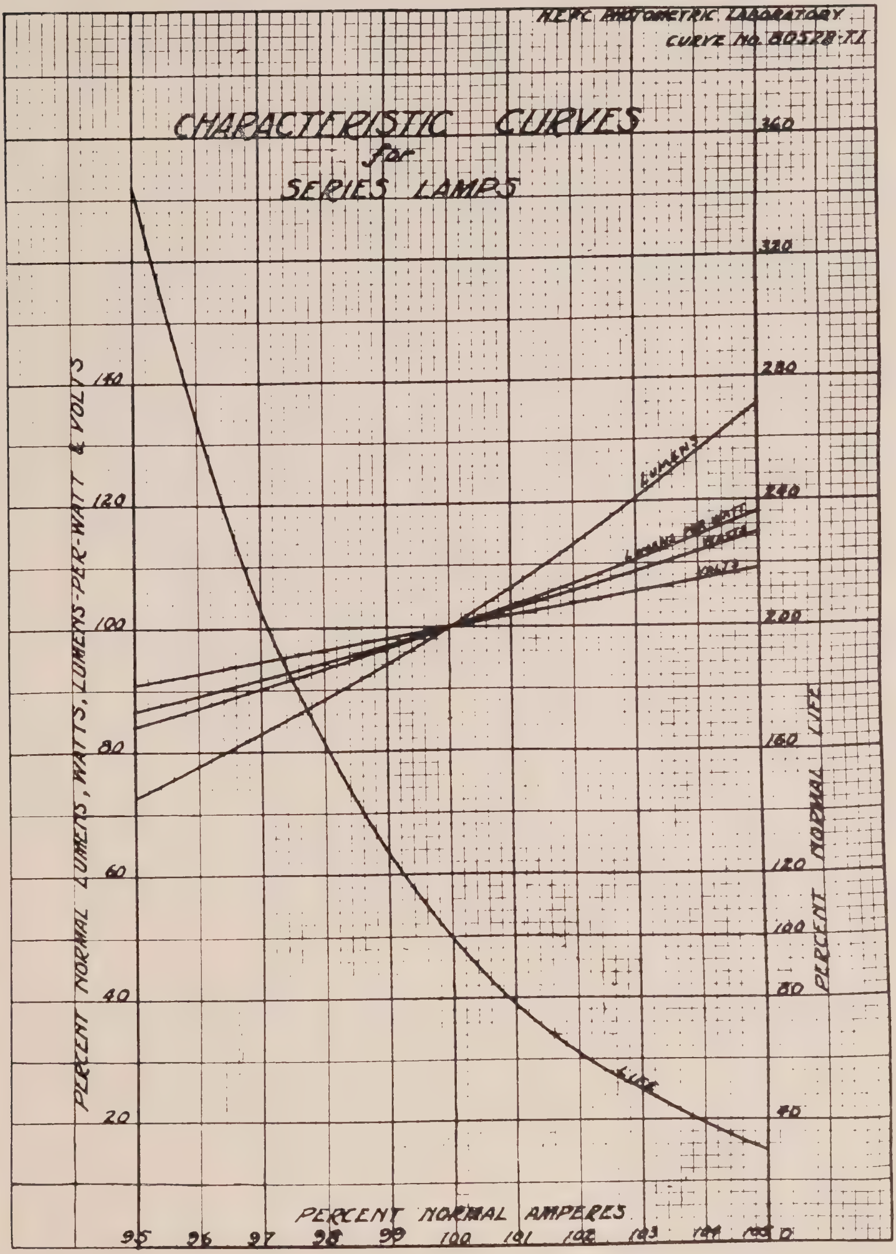



*Fig. 4*

voltage must be taken into account when estimating the required capacity of constant current transformers.

CONCLUSIONS

It should be remembered that replacements will vary from month to

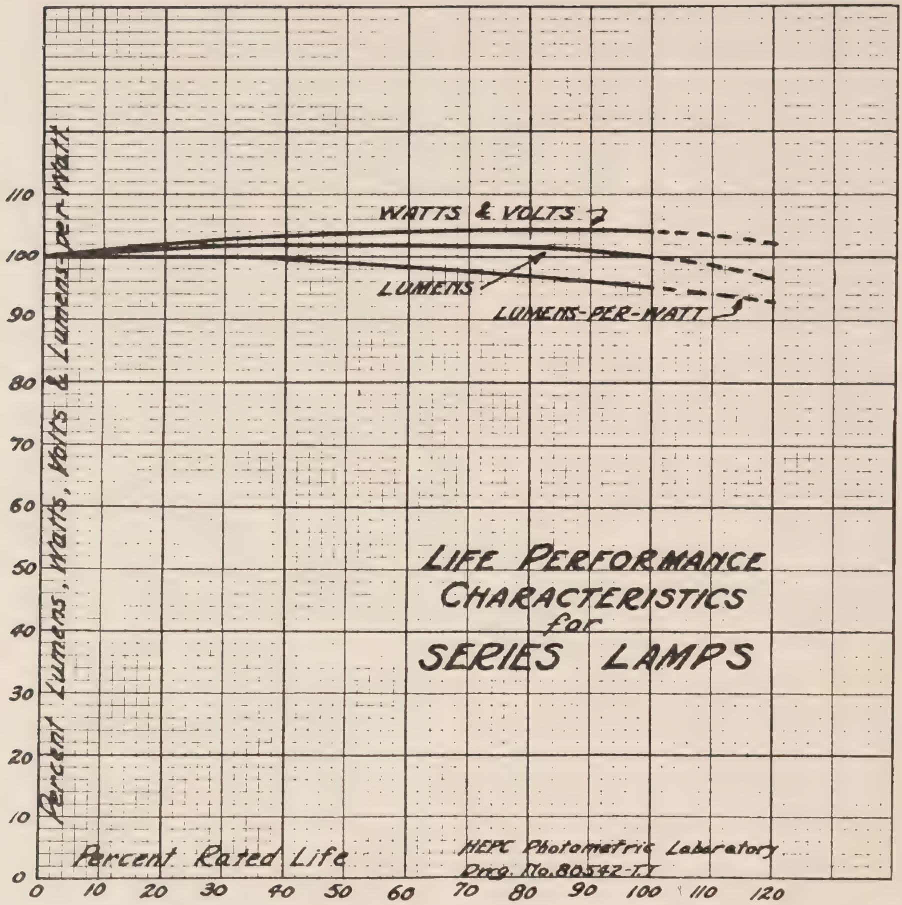



*Fig. 5*

month and that the life obtained can best be judged by the number of replacements per year. However, good life performance does not necessarily indicate good quality as lamps of poor quality may give exceptionally long life with an excessive sacrifice in light output.

Series circuits and equipment should be maintained in good condition and the current kept at the rated value. It is advisable to periodically check the switchboard ammeter by an accurately calibrated instrument to eliminate a possible source of trouble.

Economical street lighting is not solved by simply using good quality lamps under proper conditions. The light must be delivered to the roadway with a minimum loss. This loss can be reduced by the use of modern lighting fixtures and a regular cleaning schedule. Lighting fixtures are designed for a certain size lamp and will not give the desired distribution when equipped with lamps of any other size.

# THE BULLETIN

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# Experience With Overhead Shielded Primary Cable


By G. L. Lillie, Assistant Distribution Engineer,
Toronto Hydro-Electric System


OVERHEAD power distribution, using weatherproof braid covered conductors, supported by insulators on crossarms or brackets, is universally acknowledged as the most practical method of power distribution, per capital invested. In appearance, however, it is neither attractive, nor inconspicuous as is the underground system.

In residential districts, where primary has to be extended on small poles unsuitable for open high voltage lines, such as concrete, steel or wood, the whole line has to be rebuilt to add, in most cases, only one conductor. Where trees are prevalent, (as in most residential sections) they must be kept trimmed, and often mutilated, in order to give clearance. Otherwise still higher poles are required.

Underground construction makes the ideal distribution system, but the cost is often prohibitive. A compromise may, therefore, be welcome, and possibly, insulated aerial cable, which can be strung on existing poles, and thus avoid expensive reconstruction, is the solution.

For these reasons the Toronto Hydro-Electric System has for some time been experimenting with different forms of overhead insulated primary cable, especially where necessary to feed small single phase transformer banks of from 50 to 100 kw. in residential districts.

Grounded shielding over the insulation is provided for greater safety, so that if a fault in the insulation should occur, its presence will immediately be detected and the conductor isolated and cleared.

From 1913 to 1929 inclusive, many installations were made of various

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## CONTENTS

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**November, 1939**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

types of cable, both paper and rubber insulated and shielded either with lead or some form of iron or bronze alloy wire. The make-up of the different types are listed in Table No. 1, and their chronological history is recorded in Table No. 2. Only partial success can be reported. The first two installations were No. 4, 3 core p.i.l.c. cables suspended on messengers, only one conductor being used, the common neutral making the return circuit, Type No. 1. These installations followed standard practice for aerial cable, but for short single conductor primary extensions on residential streets, a more flexible and less expensive type of cable was considered advisable.

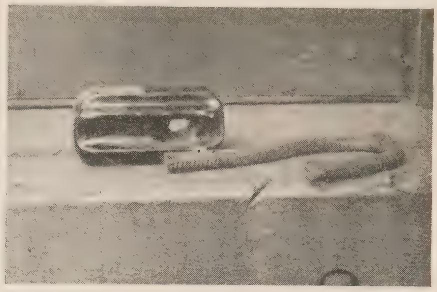


*Fig. 1—Defect due to poorly designed deadend.*

Our oldest active non-leaded cable, Type No. 4, was installed in 1922, supported without a messenger, and has given nearly seventeen years of trouble-free service. The System also has two other veterans erected in the two following years, which have equally clear records. Both are Type No. 6 and are self-supporting.

In 1924 the first installation of Type No. 7 cable was erected self-supporting. Nine years later a ground developed and at first it was thought that both rubber insulation and braid armour were badly deteriorated, and it was replaced with p.i.l.c. cable on a messenger. On test, however, the only defect was found to be where a poorly designed deadend had squeezed the rubber between the armour and the conductor so that a puncture had taken place. (Fig. 1.) This cable was again installed at another location, and has already added another 6 years' service to the original 9. (Table No. 2.)

Five installations were replaced with p.i.l.c. cable, Type No. 9, in 1928, supposedly due to deterioration of the rubber insulation, and brought to notice by radio interference. After test made in 1933, we are not so posi-

## TABLE NO. 1

Types of Overhead Shielded Primary Cable Used by T.H.E.S.

| No. | Mfg. | Conductor | Insulation | Shielding and Braid | Cost ¢ per ft. | Length in ft. |
|---|---|---|---|---|---|---|
| 1 | | No. 4 and No. 6, 3 core | paper | lead | | 1,275 |
| 2 | B | No. 8 single stranded | rubber—approx. $\frac{7}{32}$ in. | lead covered and cu. clad steel wire | 40 | 1,000 |
| 3 | A | No. 7 strand. cad. bronze | .188 in., 30 percent Para r. rubberized tape | .0126 in. steel wire arm., creosote paint | 16 | 2,000 |
| 4 | B | No. 8 stranded | $\frac{4}{32}$ in., 30 percent Para r., $\frac{1}{32}$ in. v.c. and jute bedding | No. 12 gal. steel wire | 20.7 | 1,000 |
| 5 | C | No. 8 stranded | $\frac{4}{32}$ in. r., two tapes | No. 28 steel wire braid | 14 | 1,000 |
| 6 | B | No. 7 stranded | rubber | No. 12 c.c. steel wire | 34 | 3,000 |
| 7 | A-C | No. 7 cad. (7 by .054 in.) | .25 in., 40 percent r., 2 tapes | No. 28 cadmium wire braid | 24.2 | 9,000 |
| 8 | C-B | No. 6 | rubber | lead | 20 | 19,900 |
| 9 | C-B | No. 6 | paper | lead | | |
| 10 | D | .0225 sq. in. strand | v.c. jute braided | 23 by .072 in. al. alloy wire, jute braid and comp. | 24.2 | 2,640 |
| 11 | E | No. 6 solid Hi-Tenso | $\frac{9}{64}$ in. special r. comp., fabric tape | 10 mil bronze tape, seine twine braid | 22 | 21,000 |
| 12 | E | No. 6 solid | $\frac{9}{64}$ in. special r. comp., fabric tape jute bedding | No. 14 al. wire armour | 30 | 1,000 |
| 13 | B | No. 6 solid, m.h. | varnished cambric | 2 cu. tapes, 40 percent r. belt, double side r. f. tape | 18.1 | 1,000 |
| 14 | F | 7 by .064 in. m.h. | $\frac{9}{64}$ in. special India r., v.c. tape | Fine cu. wire braid, 2 impreg. paper, s.c.c. red lead compound and cot. braid | 12-15 | 25,000 |
| 15 | B | No. 6 solid, m.h. | .125 in. v.c. r.f. tape, w.p. braid | 2 cu. tapes, w.p. braid overall | 16.8 | 10,000 |
| 16 | B | No. 6, 7-strand, m.h. | .1 in. a.o. r., r.f. tape, .05 in. v.c. tape, plain cambric tape | 2-5 mil cu. tapes, heavy w.p. braid | 14.6 | 5,000 |
| 17 | B | No. 6 strand, m.h. | .094 in. special r. .05 in. v.c. tape, r.f. tape, heavy paper tape | 2-5 mil cu. tapes, single w.p. braid | 14.8 | 5,000 |
| 18 | C | No. 6 stranded | $\frac{8}{64}$ in. special r., r. tape | 2-5 mil annealed cu. tapes and hawser cord braid | 12 | 10,000 |
| 19 | B | No. 6 solid | .11 in. saturated paper | .65 in. lead, cot. tape, No. 16 gal. steel wire | 15.3 | 5,000 |
| 20 | B | No. 6 solid | $\frac{6}{64}$ in. special r., rubberized tape, cot. braid | .035 in. special fibre tape arm., cot. sheath | 13.8 | 1,400 |
| 21 | C | No. 6 (2) stranded | $\frac{8}{64}$ in. special r., layer tape each, and stranded with jute | layer of cu. tape, and braid of hawser cord in flame proof compound | 20.4 | 500 |
| 22 | B | No. 6, 7-strand | $\frac{8}{64}$ in. special corona resisting r., cot. tape | double layer of 5-mil copper tape, w.p. braid | 14.8 | 5,000 |
| 23 | B | No. 8 stranded | $\frac{8}{64}$ in., 30 percent r., d.f.r. tape, 2 v.c. tapes d.f.r. tape and jute bed. | No. 15 gal. steel wire arm. with w.p. braid | 17.0 | 5,000 |
| 24 | A-B-C | No. 6 strand | $\frac{8}{64}$ in., 40 percent r., cot. tape | 2-5 mil soft cu. tapes, cot. hawser cord | 14.75 | 20,000 |
| | | | | braid | 12.69 | 20,000 |
| | | | | | | 175,715 |

TABLE NO. 2
SUMMARY OF SHIELDED PRIMARY INSTALLATIONS 1913 TO 1930 (INCLUSIVE)

| Type | Installed | | | Totals | | Totals | | | Removed | | | In Service | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Year | Feet | No. | Feet | Year | No. | Feet | No. | Year | Feet | No. | Feet |
| 1 | 2 | 1913 | 1,275 | 2 | 1,275 | '13 | 2 | 1,275 | | | | 2 | 1,275 |
| 2 | 1 | 1922 | 330 | | | | | | 1 | 1925 | 330 | 0 | 0 |
| | | | | | | | | | Pole line rebuilt | | | | |
| | 2 | 1926 | 670 | 3 | 1,000 | | | | | | | 2 | 670 |
| 3 | 2 | 1922 | 1,700 | 2 | 1,700 | | | | 2 | 1925 | 1,700 | 0 | 0 |
| | | | | | | | | | Pole line rebuilt | | | | |
| 4 | 1 | 1922 | 1,000 | 1 | 1,000 | '22 | 4 | 3,030 | | | | 1 | 1,000 |
| 5 | 1 | 1923 | 400 | | | | | | 1 | 1925 | x400 | 0 | 0 |
| | 1 | 1925 | 758 | 2 | 1,158 | | | | 1 | 1928 | x758 | 0 | 0 |
| 6 | 2 | 1923 | 1,150 | | | '23 | 3 | 1,550 | 1 | 1925 | x500 | 1 | 650 |
| | 2 | 1924 | 880 | | | | | | 1 | 1925 | 450 | 1 | 430 |
| | 2 | 1928 | 828 | 6 | 2,858 | | | | Pole line rebuilt | | | 2 | 828 |
| 7 | 1 | 1924 | 685 | | | '24 | 3 | 1,565 | 1 | 1933 | x685 | 0 | 0 |
| | | | | | | | | | re-erected | | in 1933 | | |
| | 6 | 1925 | 3,893 | | | '25 | 7 | 4,651 | 1 | 1931 | x936 | 5 | 2,957 |
| | 8 | 1926 | 3,370 | | | | | | 5 | 1928 | x2,120 | 3 | 1,250 |
| | 1 | 1928 | 700 | | | | | | | | | 1 | 700 |
| | 1 | 1933 | 574 | 17 | 9,222 | | | | | | | 1 | 574 |
| 8 | 8 | 1926 | 4,140 | 8 | 4,140 | '26 | 18 | 8,180 | 2 | 1930 | 950 | 6 | 3,190 |
| | | | | | | | | | Pole line rebuilt | | | | |
| 9 | 1 | 1927 | 740 | | | '27 | 1 | 740 | | | | 1 | 740 |
| | 7 | 1928 | 3,320 | | | '28 | 10 | 4,848 | | | | 7 | 3,320 |
| | 6 | 1929 | 3,057 | | | '29 | 6 | 3,057 | | | | 6 | 3,057 |
| | 4 | 1930 | 2,250 | | | '30 | 4 | 2,250 | | | | 4 | 2,250 |
| | 10 | 1931 | 5,196 | | | '31 | 10 | 5,196 | | | | 10 | 5,196 |
| | 2 | 1933 | 1,231 | 30 | 15,794 | '33 | 3 | 1,805 | | | | 2 | 1,231 |
| | 71 | | 28,147 | 71 | 38,147 | | 71 | 38,147 | 16 | | 8,829 | 55 | 29,318 |

x Replaced with Type No. 9 due to breakdown

tive that this was warranted. We are only sure now, that one type—No. 5—was definitely not satisfactory.

No further cables were erected after 1924 self-supporting, i.e., without a messenger, and by 1929 the only type used was p.i.l.c., and hopes for non-leaded, lightweight, and low cost, insulated primary appeared to be remote.

A review of the merits and failures of this class of primary conductor was made, and the possibility of some improvement in the design was considered. The good points of an aerial cable with grounded sheath, were still appreciated but it was found that its cost, together with the supporting messenger, was almost equal to the cost of changing poles and installing open primary or crossarms. What was required, was a self-supporting, insulated conductor that could be strung like weatherproof wire, and deadended, and jointed, readily and without excessive cost. Rubber insulation, with some form of wire armour, appeared to be logical, but the perishing of the rubber and the rusting or otherwise mechanical breaking down of the armour was discouraging. Much of our trouble appeared to be due to poor methods of holding, or deadending the cable. In search of help a circular letter was prepared, describing our problem, and sent to every known wire manufacturer—in Canada, the United States and England. The replies were, in most instances, not very helpful. Two firms, however, submitted cable designs and quotations, that were interesting and in 1930 trial orders were placed, one in New York City, Type Nos. 11 and 12, and the other in England, Type No. 10. These were made up as per Table No. 1 and installed as indicated in Table No. 3, with very favorable results. Further developments in cable design followed, producing new types and additional installations were made as also shown in Table No. 3.

Of these, only Type No. 19 was unsatisfactory. This was an attempt to make a wire armoured p.i.l.c. cable self-supporting, but due, possibly, to the short lay of the wire armour and the consequent twisting and stretching of the cable, the mechanical strain on the lead sheath was too severe and our first installation broke down shortly after being put in service. It then became necessary to provide a messenger in order to use this as an aerial conductor. It is still working, but the result in appearance and cost is not good.

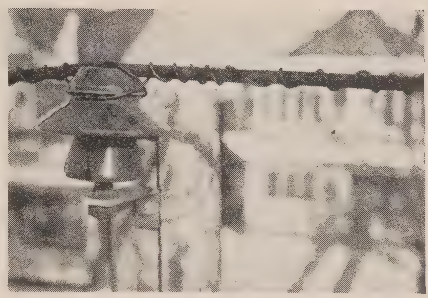


*Fig. 2—Tree wire, insulated with rubber, covered with fibre tape armour.*

Another radical departure was made in the use of 1400 feet of tree wire (Type No. 20), insulated with rubber, covered with fibre tape armour. (Fig. 2). This was installed on long top extensions and for further protection a bare copper wire was wound around the conductor for a distance of about three feet on each side of line insulator and grounded to the common neutral.

In Type No. 21 we had need for a two conductor cable to use on a 2300 volt delta connected feeder. Only enough cable for the one extension was purchased.

After seven years of experimental

TABLE NO. 3

SUMMARY OF SHIELDED PRIMARY INSTALLATIONS 1913 TO AUGUST 31, 1939

| Type | Installed | | | Totals | | Totals | | | Removed | | | In Service | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Year | Feet | No. | Feet | Year | No. | Feet | No. | Year | Feet | No. | Feet |
| 10 | 4 | 1931 | 1,810 | | | | | | | | | 4 | 1,810 |
| | 1 | 1931 | 600 | 5 | 2,410 | | | | | | | 1 | 600 |
| 11 | 2 | 1930 | 1,000 | | | '30 | 8 | 3,760 | | | | 2 | 1,000 |
| | 26 | 1931 | 12,973 | | | '31 | 27 | 13,573 | 1 | 1932 | 805 | 25 | 12,168 |
| | 10 | 1932 | 7,640 | 38 | 21,613 | | | | Pole line rebuilt for primary feeders | | | 10 | 7,640 |
| 12 | 2 | 1930 | 950 | 2 | 950 | | | | | | | 2 | 950 |
| 13 | 2 | 1932 | 1,000 | 2 | 1,000 | | | | | | | 2 | 1,000 |
| 14 | 8 | 1932 | 5,000 | | | | | | | | | 8 | 5,000 |
| | 33 | 1933 | 19,440 | | | | | | | | | 33 | 19,440 |
| | 1 | 1934 | 305 | 42 | 24,745 | | | | | | | 1 | 305 |
| 15 | 8 | 1932 | 4,570 | | | '32 | 28 | 18,210 | | | | 8 | 4,570 |
| | 8 | 1933 | 4,717 | 16 | 9,287 | '33 | 41 | 24,157 | | | | 8 | 4,717 |
| 16 | 10 | 1934 | 4,746 | 10 | 4,746 | | | | | | | 10 | 4,746 |
| 17 | 8 | 1934 | 4,879 | 8 | 4,879 | | | | | | | 8 | 4,879 |
| 18 | 10 | 1934 | 4,892 | | | '34 | 29 | 14,822 | | | | 10 | 4,892 |
| | 3 | 1935 | 1,881 | | | '35 | 10 | 5,211 | | | | 3 | 1,881 |
| | 5 | 1936 | 2,778 | 18 | 9,551 | '36 | 5 | 3,158 | | | | 5 | 2,778 |
| 19 | 4 | 1935 | 2,230 | 4 | 2,230 | | | | | | | 4 | 2,230 |
| 20 | 2 | 1935 | 1,100 | 2 | 1,100 | | | | | | | 2 | 1,100 |
| 21 | 1 | 1935 | 380 | 1 | 380 | | | | | | | 1 | 380 |
| 22 | 11 | 1937 | 4,802 | 11 | 4,802 | | | | | | | 11 | 4,802 |
| 23 | 8 | 1937 | 4,668 | 8 | 4,668 | | | | 1 | 1937 | 552 | 7 | 4,116 |
| | | | | | | | | | Line rebuilt on opposite side of street | | | | |
| 24 | 13 | 1937 | 5,503 | | | '37 | 32 | 14,973 | | | | 13 | 5,503 |
| | 19 | 1938 | 8,041 | | | '38 | 19 | 8,041 | | | | 19 | 8,041 |
| | 15 | 1939 | 9,253 | 47 | 22,797 | '39 | 15 | 9,253 | | | | 15 | 9,253 |
| | 214 | | 115,158 | 214 | 115,158 | | 214 | 115,158 | 2 | | 1,357 | 212 | 113,801 |
| from Table No. 2 | 71 | | 38,147 | 71 | 38,147 | | 71 | 38,147 | 16 | | 8,829 | 55 | 29,318 |
| | 285 | | 153,305 | 285 | 153,305 | | 285 | 153,305 | 18 | | 10,186 | 267 | 143,119 |

work with both wire and metallic tape shielding, and rubber and varnished cambric insulation, we considered that it was time we should prepare our own specifications based on experience and requirements, so that pur-

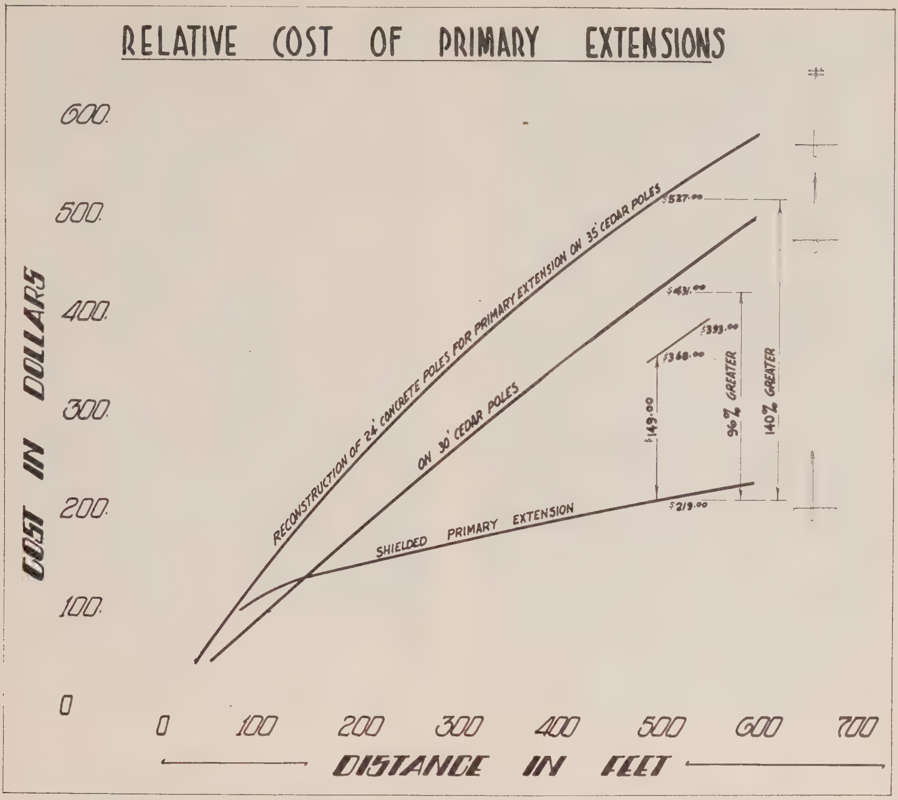



*Fig. 3.*

chasing could be done by tender, and in larger quantities. With the assistance of the manufacturers this was successfully accomplished, and in May, 1937, the first T.H.E.S. tender for the supply of 20,000 feet was called for. (Type No. 24.) An additional 20,000 feet was ordered this year, with many further requirements in sight.

At the present date, the amount of shielded primary cable purchased since June, 1930, is 137,540 feet, and the total now in service amounts to 143,119 feet or 27.1 miles. The System's 267 active installations supply 544 overhead distribution transformers of 13,100 kw. capacity, which is 7.9 per cent of the total in this class of service.

The cost of the above extensions, up to the end of August, 1939, was approximately $105,076 (not including transformers), and it has been estimated, that, if cable had not been used, it would have cost $195,562 to replace concrete poles with 35 ft. cedars, transfer lines and street lighting fixtures and string one No. 2 open primary. This represents a saving of $90,486 or $338 per extension or approximately $6.90 per kw. supplied. These figures are very conservative, as in many cases actual costs include items, such as reconstruction and re-

*Fig. 4—Shielded primary (top right) on concrete pole.*


*Fig. 5—Shielded primary making angle (top right) on steel pole.*

placing of secondaries, which are not properly a part of primary cable extensions. The average length installed to date is 537 feet. (Fig. 3.) Improved methods have lowered prices so that a 500 foot extension now costs approximately $219.31 or 44 cents per foot. This includes equipping of run-off pole with hardware and deadends, replacing one 24 foot concrete pole with new type 28 foot for transformers, transferring lines and street lighting lantern, raising one street lighting secondary one arm, installing cutout at line end, and stringing shielded primary cable. On the basis of a cost of $393 for an average length of 537 feet, or $368 per 500 feet, we have an improvement of $149 on each new installation over previous average costs. Compared with this, the present estimated cost of replacing concrete poles with 35 foot cedars and stringing one No. 2 w.p. primary wire for 500 feet is $527.36, or 140 per cent greater. This reconstruction may be necessary where heavy feeders are required, but this is seldom the case on residential streets at right angles to main thoroughfares. Even if a lead were to be reconstructed with 30 foot cedars with one open primary on pole top extensions and secondaries on brackets, the cost would be still 96 per cent greater, than if shielded primary were used.

For original construction in new residential districts, the use of shielded primary on concrete poles can, also, be more than justified. Its cost per 500 feet is only 11 per cent greater

*Fig. 6—Shielded primary (top extension) on cedar pole.*

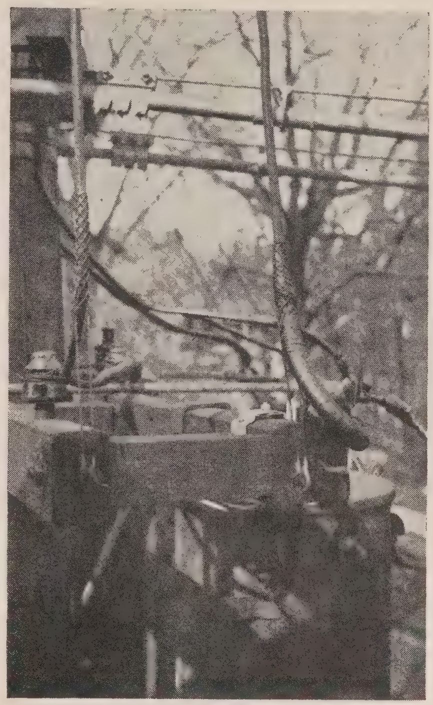


*Fig. 7—Shielded primary to transformer on joint pole construction.*

than for an open primary wire on 30 foot cedar poles, and 16 per cent less than for a 35 foot lead with cross-arms.

The improved appearance and less likelihood of complaints cannot be valuated in dollars and cents, but instructions from our Executive Department in 1934, that, "where primaries are necessary on streets having only concrete poles, they be made of insulated cable and on existing poles", speaks for itself.

In addition to the normal requirements for shielded primary on pole lines, either concrete (Fig. 4), steel (Fig. 5), or small wood (Fig. 6), several new applications have been developed. In one instance, 300 feet have been run along the side of a brick building to supply a transformer on a pole on private property. This was installed on consumer's order and obviated entirely, the necessity for a number of poles. In several cases, shielded cable is used for primary drop leads of line transformer located in close proximity to accessible parts of buildings, such as windows, fire escapes, or on small wooden poles where transformers are mounted on brackets, etc. This has also led to the Toronto Hydro-Electric System's recommendation that shielded primary cable be required to supply transformers on joint pole construction with other utilities, where transformers are located below their cable. (Fig. 7.) On another customer's property, a single phase primary service (to-

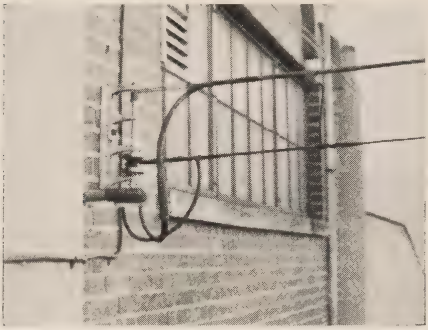


*Fig. 8—Single phase primary service attached to wall.*

*Fig. 10—Three single conductor cables entering pipe lateral.*

gether with neutral) is installed from nearest pole to wall of building where connection is made to leads in stand-pipe. (Fig. 8.)

In February of this year an experimental 4100 volt, 3 phase, underground lateral service was installed from overhead mains on opposite side of street to supply transformers inside a building. Three separate single conductor cables were individually suspended across the street between a high cedar pole and a concrete pole, and continued down pipe lateral on this pole into the underground vault,

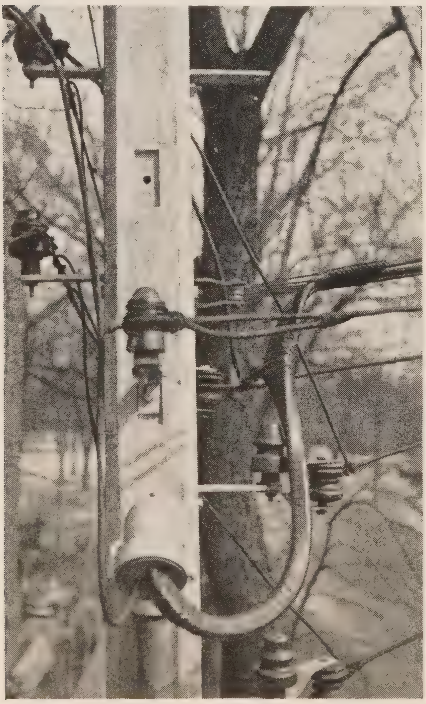


*Fig. 9—Three single conductor cables attached to concrete pole.*

*Fig. 11—Three single conductor cables crossing street.*

*Fig. 12—Construction on 45 ft. pole replaced by type shown in Fig. 13.*

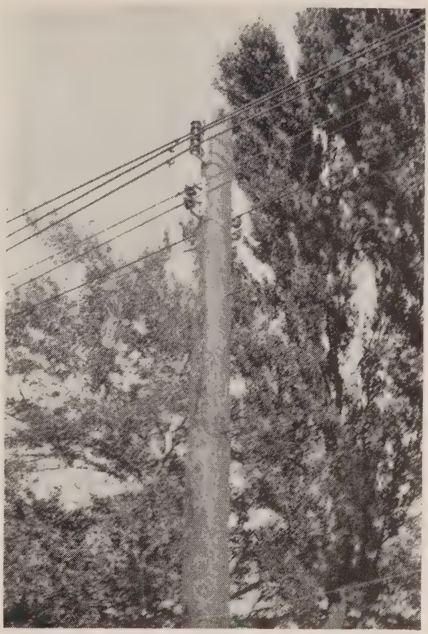


*Fig. 13—Shielded primaries on 25 ft. pole near airport.*

without joint or pothead, at less than 50 per cent of the cost of using standard p.i.l.c. cable, and with greatly improved appearance. (Figs. 9, 10 and 11.)

Another application for this type of primary cable was made recently, on the request to lower the height of a pole line adjacent to the new airport, where it crossed one of the flight ways close to the end of a runway. This line carried 2300 volt, 3 phase, primary lines and the maximum height allowed was 30 feet. By stringing shielded primary on brackets on 25 foot poles a safe and sightly construction was maintained, obviating the need for rebuilding a large pole line on a more circuitous route. (Figs. 12 and 13.)

In line with this development, just a word with regard to future possibilities of shielded primary as an alternative to extensive tree trimming, or rebuilding.

At present tree trimming costs the Toronto Hydro-Electric System approximately $13,500 annually and this is increasing. Trees grow, but poles do not.

Taking the capital cost of building a 45 foot cedar pole line (Fig. 14) with 3-No. 2 primaries, No. 0 house lighting and No. 6 street lighting secondaries, as approximately $1,400 per 1,000 feet, it can be argued that the same size lines may be installed on 30 foot poles using shielded primary at approximately the same or slightly less cost, but without the need for constant tree cutting and in loca-

*Fig. 14—A 45 ft. cedar pole line running through trees, tree trimming is necessary.*

*Fig. 15—A 30 ft. cedar pole line with secondaries only where 3 shielded primaries may be added without tree interference and at half of cost of open primaries.*

tions where a higher lead might not be possible.

Where tree growth has come after 20 or 25 years and a pole line requires replacing, a saving of $300 per 1,000 feet may be made in cutting the pole line down to 30 foot size and using shielded primary with secondaries on brackets. This saving would be increased to $500 if it were otherwise necessary to increase height of poles 10 feet.

If we have an existing 30 foot cedar lead (Fig. 15), carrying secondaries only, and require primary lines, it is possible to install 3-No. 2 shielded primaries for approximately half the cost of replacing with 45 foot cedars and stringing open primary, and at the same time avoid all primary tree interference.

CONSTRUCTION DETAILS

Of our 267 installations (not including any length in service less than one span—such as transformer leads), 55 are suspended from messengers and the balance self-supported, that is secured at each end by suitable deadends, and held on intermediate poles by means of insulators or clamps. Insulators are not necessary electrically, but as a convenient and low cost mechanical support, they have been most generally used.

In the operation of shielded cable for primary distribution, there is always present the possibility of breakdown between conductor and metallic grounded shield, if not properly installed. The insulation of the cable has, of course, a wide factor of safety in this regard, but certain conditions may cause considerable trouble unless reasonable care is taken. Two possible sources of trouble must be guarded against. One is mechanical pressure at a point on the surface of the cable, such as on an insulator at a bend or angle in the line, (particularly with some types of special rubber insulation); and the other is insufficient clearance being left between the end of the armour and the uninsulated conductor, when making a joint or deadend. If these two points are kept in mind and guarded against, very little trouble should be experienced.

Our first self-supporting cable was deadended on porcelain strain insulators by bending the cable back on itself without, however, removing the steel wire armour. This we now consider to be very severe treatment. The insulation of the cable, instead of the porcelain, was required to withstand not only the line potential but also mechanical squeezing between conductor and shield. This pressure would tend to bring conductor closer to the grounded shield and thus cause a puncture. In spite of this condition, the cable installed in December, 1922, is operating today without failure of any kind. A similar cable, the second oldest, is suspended at either end by special clamps. These do not distort the insulation to the same extent as in the previous case, but do cause compression in the rubber insulation between the ground shield and the conductor. If the area is large enough this should not be objectionable.

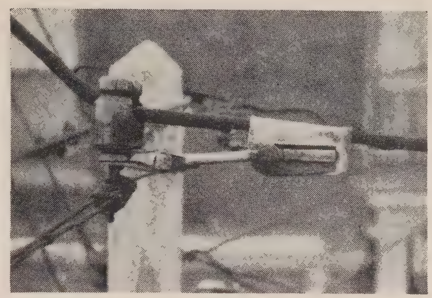


*Fig. 16—Cable without messenger, held by wedge type deadend.*

From 1926 to 1929, messenger wire was used entirely for the support of all cables erected, but in 1930 with the arrival of the first new cable from England, it was decided that this additional expense should be eliminated. As this cable was aluminum wire armoured, a wedge type deadend was selected for its support. (Fig. 16.)

For the rubber composition insulated cable from New York, an entirely different type of deadend was necessary. Due to the spiral armour and soft insulation it was proposed to take the strain of the cable on its conductor only, and accordingly a standard type "A2" clevis with strain insulator was used. (Fig. 17.) The weatherproof braid and bronze tape were removed back about 18 inches from the point of suspension and the insulated conductor passed through the strain insulator and served off with a half line joint. A weatherproof wire tap to the line or transformer (as the case may be) was also

*Fig. 17—Clevis with strain insulator deadend, no messenger.*

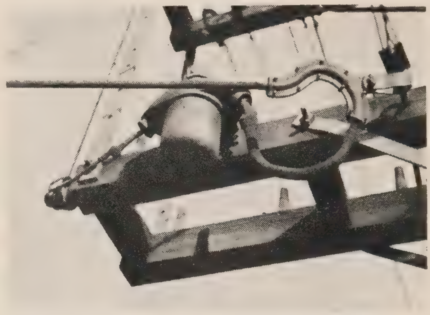


*Fig. 18—An improved type of cable grip at deadend, no messenger.*

added at the same point and the whole joint re-insulated with special rubber compound tape to $1\frac{1}{2}$ times its original thickness, and covered overall with friction tape and compounded.

At this time transformers were installed on 35 foot cedar poles only, so that all cables terminated on cedar poles, and could, therefore, be considered as "alive", that is insulated by the deadend insulator only.

This type of deadend has been quite suitable, when properly made up, but we have had a few cases of breakdown, due to leakage from conductor to armour where it has not been kept far enough away, or where moisture has been able to penetrate.

Although the clevis deadend was suitable on cedar poles, along with other open 4100 volt lines, it was not so good for use on concrete poles. The use of a shielded primary on these poles, for safety, logically calls for an insulated and shielded deadend. With the advent of transformer mounting on concrete poles, some means of holding the cable and at the same time keeping its outer covering at ground potential was necessary. Our theory—that all strain should be in the conductor and not in the insulation (unless wire armoured)—was now modified by the axiom that if the stress were distributed uniformly over a large enough surface, the result would not be detrimental. A grip was, therefore, designed of bronze with smooth surface but curved, to obtain a hold on the cable, and provided with a number of screws for uniform pressure. The first was installed in 1934, and later an improved type was developed having still greater surface and a double, or S bend. (Fig. 18.)

In 1936 a flexible wire grip of the woven basket, cable pulling type, already used for supporting service cables, was adopted as our present standard deadend (Fig. 19), and fulfils all the requirements extremely well. It is flexible, durable, strong, light in weight, inconspicuous, lower in cost and requires less labour to install.

Turns, bends or angles in the line of the cable are potential sources of trouble, particularly with rubber insulated cable, unless special pains are taken to guard against concentration of pressure. It was soon found that

*Fig. 19—Present standard deadend, flexible wire grip.*

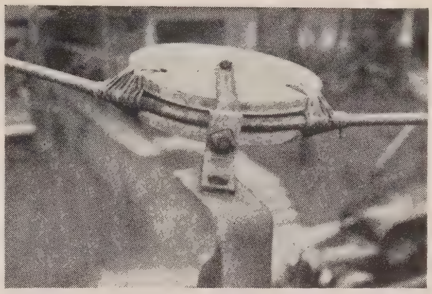


*Fig. 21—Wooden pulley used on line angle.*

ordinary line insulators were not suitable for use in making changes of direction.

In 1931, two spool, or type B insulators were combined, (Fig. 20) to relieve the pressure when rounding a corner, but even this did not prevent breakdowns from occurring. Different methods were tried to clear up this trouble. The shielding was removed past the support and layers of rubber composition tape applied around the cable to form a cushion and the shielding then replaced. Several types of flexible copper braid were used to replace the original tape. There are at present about eighty cable angles negotiated on these spool insulator arrangements, and they are all potential sources of trouble.

*Fig. 20—Spool insulator construction for rounding a corner.*

In attempting to create greater bearing surface for cable on corners, a wooden pulley (Fig. 21) (much like a clothes line pulley) was tried experimentally. The results have been 100 per cent perfect, but the appearance is not just the neatest. This experiment did influence the design of the bronze clamps for deadending. Their suitability for line angles (Fig. 22) was found to be especially good. In 1936 the woven wire grip for deadending was also applied to all angles, holding the cable in each direction most efficiently. (Fig. 23.)

The location of the cable on the concrete pole has been a debatable

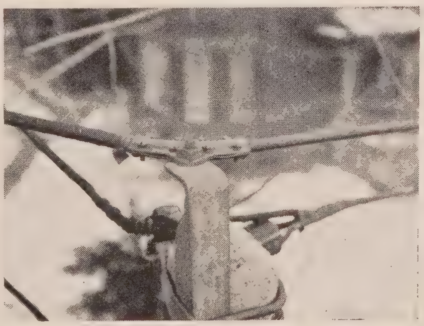


*Fig. 22—Bronze clamp type angle.*

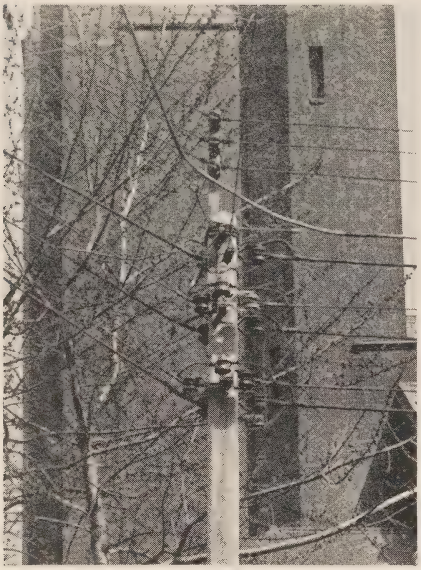


*Fig. 23—Woven wire deadend grips used on angle.*

*Fig. 24—Cable clamped directly to steel pole arm.*

matter. In the early days most of the messenger supported cables were located on short top extensions. Many of the later cables are also on top extensions. These are sometimes necessary to clear obstructions, but, on the other hand, often interfere with telephone service drops—unless rearranged. Most cable has been installed in the upper street lighting secondary position, (Fig. 4), after lowering or restringing secondary in road neutral position. The lower street lighting secondary position has also been used, and where cable is to supply transformers on concrete poles, it has advantages. Cable is protected from mechanical injury from falling objects, such as tree limbs and signs, and terminates closer to transformer cutout.

In 1937 one installation was made without line insulators. Type No. 23 cable, having steel wire armour, was suspended directly on the steel pole arms (Fig. 24), and held firmly by means of hook-shaped clips secured through the pin hole by a nut. This support is very practical, but up to the present has cost somewhat more than the conventional insulator. No suitable manufactured clip has been available, and the cost of making them to order was found to be excessive.

Splices or joints in armoured cable constitute a weak point and they have, therefore, been kept to a minimum. Linemen ordinarily have not the experience or training necessary in the making of high potential joints involving grounded armours, whether they are lead, copper or steel. All paper insulated lead covered cables on messengers were finished off by skilled underground jointers. This procedure is expensive both as to labour and material and was one of the reasons for adopting non-leaded shielded cable. The first steel wire armoured cable was jointed by weatherproof leads to cutouts at each

end and simply taped over, and it still works. On the next oldest installations porcelain tube joints were first used. Two by eleven inch porcelain tubes, filled with compound, cover each joint between cable and weatherproof wire and the ends were well taped and suspended vertically. With the use of Type No. 11 cable from New York, a very fine rubber splicing compound tape was obtained and this is now used for sealing joints on all makes of cable.

Until 1932 there was no need for any other jointing than at each dead-end, and the occasional line splice, but with transformers erected individually on concrete poles, a tap had to be made in the cable for the first transformer. In making this tap, the cable was prepared by removing weatherproof braid and armour for about 8 inches. The insulation was then, also, removed from centre for 3 inches tapering it ½ inch at each side. The end of the tap was then prepared in a similar manner, and after binding with No. 14 bare copper, and soldering, the joint was built up with splicing compound tape half lapped to 50 per cent greater thickness than original insulation. This was then covered with two layers of varnished cambric tape, and one layer of friction tape. Copper braid tape was then wound over the joint, beginning with two strands at tap armour and winding one strand each way to meet cut ends of the line armour. Braid was soldered to the armour at all three joints with a soldering iron only. The joint was completed by wrapping with friction tape and painting with compound.

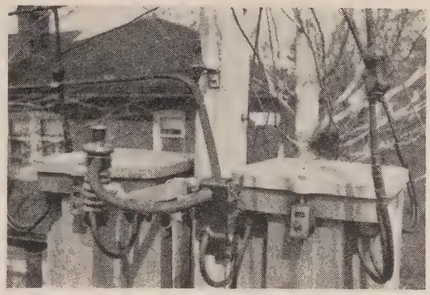


*Fig. 25—Method of connecting two transformer primaries using a transformer cutout.*

A further adoption of this tapped joint was introduced, when experimental installations of cable were made for primary drops to transformers on cedar poles. The cable, either as a separate tap, or a continuous part of the line, was brought down the face of the pole and covered with a half fiber conduit for mechanical protection. A "Y" joint was made similar to that just described, and the resulting two leads taken one to each transformer cutout, via the upper transformer crossarms.

In 1936 any further need for either "T" or "Y" joints was eliminated by the use of a transformer cutout (Fig. 25), having two connections on the line side, thus permitting of an entirely separate piece of cable to be used for the second transformer, either on the same pole or the adjacent one.

*(To be continued)*

# The Use of Electrical Appliances in Ontario

## Results of Surveys of Number of Appliances in Use in Hydro Municipalities and Rural Power Districts

SUBMITTED herewith are tables showing the results of surveys made in Hydro municipalities and in Hydro rural power districts and giving the estimated number of electrical appliances in use by urban and rural consumers at the end of 1938, as follows:

Table No. 1—Estimated number and per cent of saturation of major electrical appliances in use by domestic consumers in urban municipalities.

Table No. 2—Comparison by systems of saturation of major electrical appliances in use by domestic consumers in urban municipalities.

Table No. 3—Estimated number by systems of major electrical appliances in use among hamlet consumers in rural power districts.

Table No. 4—Estimated number by systems of major electrical appliances in use among farm rural consumers.

Table No. 5—Comparison of per cent of saturation of appliances in use in homes of urban and rural consumers.

Table No. 6—Comparison between 1937 and 1938 of the estimated number of appliances in use by rural consumers.

As in former years, all Hydro municipalities and rural power districts were asked to submit a report showing the number of appliances in use. In some cases all customers were canvassed and an actual count taken. In others, where previous surveys had been made, estimates were prepared of the increases since that survey, and in other cases, estimates were made based upon the knowledge of the management of the municipality of actual

TABLE No. 1

TABLE SHOWING ESTIMATED NUMBER OF MAJOR ELECTRICAL APPLIANCES IN USE AMONG DOMESTIC CONSUMERS AT END OF 1938 IN URBAN MUNICIPALITIES

| Appliances | Number | Saturation |
|---|---|---|
| ELECTRIC | | % |
| Ranges | 149,390 | 29.6 |
| Hot Plates | 91,556 | 18.1 |
| Washers | 258,792 | 51.2 |
| Vacuum Cleaners | 169,880 | 33.6 |
| Water Heaters (Flat Rate) | 53,355 | 10.6 |
| Water Heaters (Metered) | 48,761 | 9.7 |
| Grates | 36,985 | 7.3 |
| Air Heaters | 156,841 | 31.1 |
| Ironing Machines | 13,329 | 2.6 |
| Irons | 504,257 | 99.8 |
| Refrigerators | 94,376 | 18.7 |
| Toasters | 313,873 | 62.1 |
| Grills | 49,582 | 9.8 |
| Furnace Blowers and Oil Burners | 26,482 | 5.2 |
| Air Conditioners | 3,322 | 0.7 |
| Radios | 402,837 | 79.7 |

Number of Consumers.. 505,100

TABLE No. 2

TABLE SHOWING COMPARISON OF SATURATION OF MAJOR ELECTRICAL APPLIANCES IN USE BY DOMESTIC CONSUMERS IN URBAN MUNICIPALITIES AT END OF 1938 IN EACH SYSTEM.

| Appliances | All Systems | Niagara System | Georgian Bay System | Eastern System | Thunder Bay System |
|---|---|---|---|---|---|
| ELECTRIC | % | % | % | % | % |
| Ranges | 29.6 | 28.9 | 17.6 | 32.9 | 46.2 |
| Hot Plates | 18.1 | 15.6 | 32.5 | 19.6 | 57.9 |
| Washing Machines | 51.2 | 53.7 | 44.6 | 35.1 | 56.3 |
| Vacuum Cleaners | 33.6 | 36.3 | 19.0 | 20.4 | 39.1 |
| Water Heaters (Flat Rate) | 10.6 | 10.7 | 3.6 | 11.0 | 20.9 |
| Water Heaters (Metered) | 9.7 | 8.5 | 5.9 | 17.4 | 16.4 |
| Grates | 7.3 | 8.2 | ..... | 4.3 | 6.3 |
| Heaters | 31.1 | 32.5 | 15.5 | 26.3 | 33.7 |
| Ironing Machines | 2.6 | 2.8 | 1.3 | 1.7 | 2.4 |
| Irons | 99.8 | 100.1 | 88.1 | 93.5 | 102.2 |
| Refrigerators | 18.7 | 20.3 | 12.1 | 11.4 | 9.5 |
| Toasters | 62.1 | 61.2 | 59.3 | 61.7 | 67.6 |
| Grills | 9.8 | 7.5 | 11.6 | 19.7 | 13.6 |
| Blowers and Burners | 5.2 | 5.6 | 3.4 | 3.8 | 2.1 |
| Air Conditioners | 0.7 | 0.6 | 0.2 | 0.7 | 1.9 |
| Radios | 79.7 | 80.2 | 73.2 | 71.9 | 88.4 |

conditions. Reports were not received from a small percentage of the municipalities. Based on the reports received, estimates have been compiled in such a way as to produce, as nearly as possible, a record of the number of appliances in use among all Hydro consumers in Ontario.

Examination of Table No. 1 shows that some appliances have reached a dense saturation, but in comparison with others, there is a large field for education and promotion. Irons and radios are over 75 per cent saturation; washers and toasters are over 50 per cent; while ranges are 29.6 per cent; refrigerators, 18.7 per cent, and flat rate water heaters, 10.6 per cent.

Table No. 2 shows the difference in saturation points of various appliances in different parts of the province. The causes for these differences vary. The rates may be higher and the habits of the people may be different, or the population may be more concentrated, as in the Thunder Bay system, with the result that in the past a much greater sales effort has been made in some parts of the province than in others.

Table No. 3 gives data for hamlet rural consumers, who are consumers living in hamlets and small villages included in the rural power districts operated by the Commission. They are similar to urban consumers and

TABLE No. 3

Table showing estimated number of major Electrical Appliances in use among Hamlet consumers in Rural Power Districts at end of 1938

| | ALL SYSTEMS | | NIAGARA SYSTEM | | GEORGIAN BAY SYSTEM | | EASTERN SYSTEM | |
|---|---|---|---|---|---|---|---|---|
| | No. of Appliances | Per Cent of Saturation | No. of Appliances | Per Cent of Saturation | No. of Appliances | Per Cent of Saturation | No. of Appliances | Per Cent of Saturation |
| In The Barn | | | | | | | | |
| Electric | | | | | | | | |
| Motor | 1,753 | 3.7 | 1,174 | 3.9 | 108 | 1.6 | 471 | 4.3 |
| Pump | 517 | 1.1 | 367 | 1.2 | 35 | 0.5 | 115 | 1.1 |
| Grain Grinder | 8 | .... | 8 | .... | ..... | .... | ..... | .... |
| Milking Machine | 6 | .... | 1 | .... | 3 | .... | 2 | .... |
| Milk Cooler | ..... | .... | ..... | .... | ..... | .... | ..... | .... |
| Cream Separator | 58 | 0.1 | 9 | .... | 28 | 0.4 | 21 | 0.2 |
| Churn | 9 | .... | 5 | .... | 2 | .... | 2 | .... |
| Incubator | 49 | 0.1 | 45 | 0.1 | ..... | .... | 4 | .... |
| Brooder | 42 | 0.1 | 30 | 0.1 | 2 | .... | 10 | 0.1 |
| Hot Bed | 12 | .... | 6 | .... | ..... | .... | 6 | .... |
| Water Heater F.R. | 3 | .... | ..... | .... | 3 | .... | ..... | .... |
| Water Heater Met. | 2 | .... | 2 | .... | ..... | .... | ..... | .... |
| Miscellaneous | 483 | 1.0 | 396 | 1.3 | 5 | .... | 82 | 0.8 |
| In The Home | | | | | | | | |
| Electric | | | | | | | | |
| Range | 5,944 | 12.5 | 4,102 | 13.7 | 648 | 9.4 | 1,194 | 11.1 |
| Hot Plate | 11,095 | 23.4 | 5,980 | 20.0 | 2,012 | 29.2 | 3,103 | 28.7 |
| Washer | 21,337 | 44.9 | 14,326 | 48.0 | 2,416 | 35.1 | 4,595 | 42.5 |
| Vacuum Cleaner | 6,393 | 13.4 | 4,471 | 15.0 | 521 | 7.6 | 1,401 | 12.9 |
| Water Heater F.R. | 1,561 | 3.3 | 1,247 | 4.2 | 71 | 1.0 | 243 | 2.2 |
| Water Heater Met. | 956 | 2.0 | 640 | 2.1 | 63 | 0.9 | 253 | 2.3 |
| Grate | 400 | 0.8 | 227 | 0.7 | 43 | 0.6 | 130 | 1.2 |
| Port. Air Heater | 3,594 | 7.6 | 2,163 | 7.2 | 383 | 5.5 | 1,048 | 9.2 |
| Ironer | 593 | 1.2 | 354 | 1.2 | 79 | 1.1 | 160 | 1.4 |
| Hand Irons | 34,230 | 72.1 | 21,755 | 72.9 | 4,646 | 67.5 | 7,829 | 72.5 |
| Refrigerator | 5,723 | 12.1 | 3,930 | 13.2 | 570 | 8.3 | 1,223 | 11.3 |
| Toaster | 23,639 | 49.7 | 14,499 | 48.6 | 3,314 | 48.1 | 5,826 | 53.9 |
| Radio | 32,677 | 68.8 | 21,213 | 71.1 | 4,003 | 58.1 | 7,461 | 69.1 |
| Furnace Blower | 822 | 1.7 | 618 | 2.1 | 15 | 0.2 | 189 | 1.7 |
| Pump | 5,423 | 11.4 | 3,615 | 12.1 | 559 | 8.1 | 1,249 | 11.5 |
| Miscellaneous | 1,927 | 4.1 | 1,762 | 5.9 | 116 | 1.7 | 49 | 0.4 |

TABLE No. 4

TABLE SHOWING ESTIMATED NUMBER OF MAJOR ELECTRICAL APPLIANCES IN USE AMONG FARM RURAL CUSTOMERS AT THE END OF 1938

| | ALL SYSTEMS | | NIAGARA SYSTEM | | GEORGIAN BAY SYSTEM | | EASTERN SYSTEM | |
|---|---|---|---|---|---|---|---|---|
| | No. of Appliances | Per Cent of Saturation | No. of Appliances | Per Cent of Saturation | No. of Appliances | Per Cent of Saturation | No. of Appliances | Per Cent of Saturation |
| IN THE BARN | | | | | | | | |
| ELECTRIC | | | | | | | | |
| Motor | 7,650 | 16.7 | 5,327 | 16.1 | 921 | 21.6 | 1,402 | 16.6 |
| Pump | 6,125 | 13.3 | 4,898 | 14.8 | 431 | 10.1 | 796 | 9.4 |
| Grain Grinder | 2,488 | 5.4 | 1,783 | 5.4 | 440 | 10.3 | 265 | 3.1 |
| Milking Machine | 1,317 | 2.9 | 833 | 2.5 | 71 | 1.6 | 413 | 4.9 |
| Milk Cooler | 800 | 1.7 | 583 | 1.7 | 52 | 1.2 | 165 | 1.9 |
| Cream Separator | 3,070 | 6.7 | 1,927 | 5.8 | 312 | 7.3 | 831 | 9.8 |
| Churn | 496 | 1.1 | 365 | 1.1 | 48 | 1.1 | 83 | 1.0 |
| Incubator | 537 | 1.2 | 383 | 1.2 | 55 | 1.3 | 99 | 1.2 |
| Brooder | 469 | 1.0 | 327 | 1.0 | 41 | 0.9 | 101 | 1.2 |
| Hot Bed | 35 | 0.1 | 25 | .... | 1 | .... | 9 | 0.1 |
| Water Heater F.R. | 84 | 0.2 | 73 | 0.2 | 6 | .... | 5 | .... |
| Water Heater Met. | 47 | 0.1 | 26 | .... | 10 | .... | 11 | .... |
| Miscellaneous | 467 | 1.0 | 336 | 1.0 | 102 | 2.3 | 29 | 0.3 |
| IN THE HOME | | | | | | | | |
| ELECTRIC | | | | | | | | |
| Range | 7,899 | 17.2 | 6,911 | 20.8 | 332 | 7.8 | 656 | 7.8 |
| Hot Plate | 9,977 | 21.7 | 7,148 | 21.6 | 1,035 | 24.3 | 1,794 | 21.2 |
| Washer | 26,241 | 57.2 | 20,155 | 60.8 | 2,200 | 51.6 | 3,886 | 46.0 |
| Vacuum Cleaner | 6,175 | 13.5 | 5,010 | 15.1 | 356 | 8.3 | 809 | 9.1 |
| Water Heater F.R. | 1,821 | 4.0 | 1,716 | 5.2 | 30 | 0.1 | 75 | 0.9 |
| Water Heater Met. | 913 | 2.0 | 741 | 2.2 | 45 | 1.0 | 127 | 1.5 |
| Grate | 344 | 0.7 | 268 | 0.8 | 17 | .... | 59 | 0.7 |
| Port. Air Heater | 4,153 | 9.1 | 3,235 | 9.7 | 258 | 6.1 | 660 | 7.8 |
| Ironer | 506 | 1.1 | 323 | 1.0 | 65 | 1.5 | 118 | 1.4 |
| Hand Irons | 35,141 | 76.6 | 26,677 | 80.5 | 2,944 | 69.1 | 5,520 | 65.4 |
| Refrigerator | 5,428 | 11.8 | 4,136 | 12.5 | 402 | 9.4 | 890 | 10.5 |
| Toaster | 23,543 | 51.4 | 17,962 | 54.2 | 1,721 | 40.4 | 3,860 | 45.7 |
| Radio | 32,224 | 70.3 | 24,002 | 72.4 | 2,651 | 62.2 | 5,571 | 66.0 |
| Furnace Blower | 742 | 1.6 | 592 | 1.8 | 23 | .... | 127 | 1.5 |
| Pump | 6,977 | 15.2 | 5,433 | 16.4 | 597 | 14.0 | 947 | 11.2 |
| Miscellaneous | 1,518 | 3.3 | 1,448 | 4.4 | 41 | 0.9 | 29 | 0.3 |

a comparison of home appliances with Table No. 2 is interesting. In almost all cases the saturation is less, indicating that, although the buying power of these consumers is less, the educational and sales efforts exerted by the manufacturers and dealers have been much less than in the cities and towns.

Table No. 4 covers farm rural consumers in the different Hydro systems and shows the variation in saturation of farm and home appliances in the different systems.

Table No. 5 is given to show how the hamlet and farm housewife is making use of electrical appliances, as compared with those in urban municipalities. Electric washing machines and radios are almost as common in the hamlet and farm homes as in the urban, while other appliances are not far behind.

Table No. 6 shows that, while the number of appliances in use both in the barn and the home has increased considerably, the saturation has not increased in proportion. The growth in the number of consumers leaves a large field for education and sales promotion.

All of these tables indicate that, although there is a fairly high saturation of electrical equipment, there is still considerable room for improvement. The addition of almost 8,000 farm consumers last year opens a large field of prospects for farm equipment as well as household appliances.

It is estimated that the average home in Ontario is not more than 25 per cent saturated with electrical appliances. The average consumption in urban homes of Ontario is 1,980 kilowatt-hours per year, while an average home could easily consume 8,000 to 10,000 kilowatt-hours per year. There is, therefore, a possibility of increasing the average consumption more than four times by the greater use of electrical appliances.

Natural gas and municipal gas plants greatly affect the increase in the use of electric ranges, and the absence of waterworks systems curtails the use of water heaters in many municipalities and rural power districts. Notwithstanding these deterrents, we are still some distance from the saturation point for many electrical appliances throughout the province.

TABLE No. 5

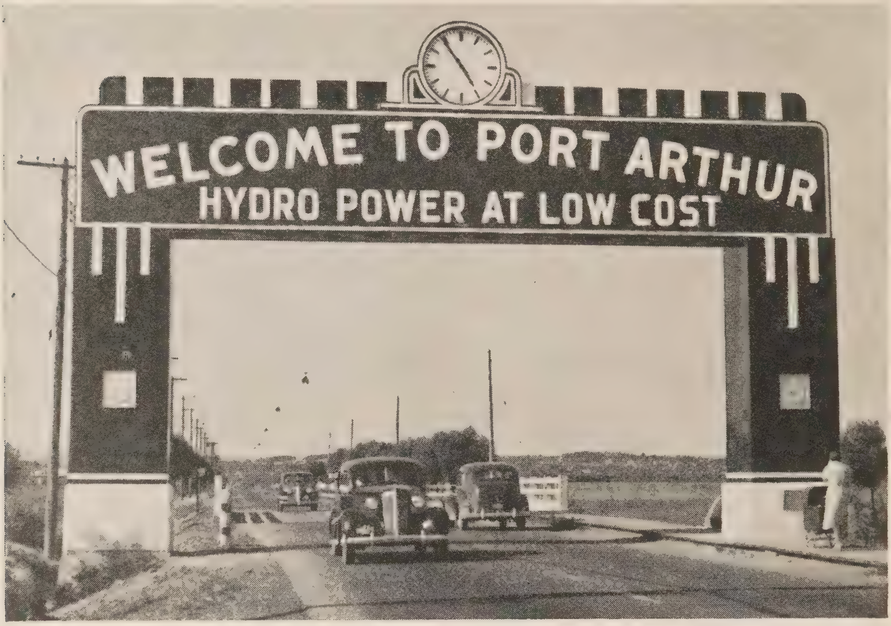
Comparison of Appliances in Use in Homes of Urban and Rural Consumers at End of 1938

| | Urban % of Saturation | R.P.D. Hamlet % of Saturation | R.P.D. Farm % of Saturation |
|---|---|---|---|
| Electric | | | |
| Ranges | 29.6 | 12.5 | 17.2 |
| Hot Plates | 18.1 | 23.4 | 21.7 |
| Washing Machines | 51.2 | 44.9 | 57.2 |
| Vacuum Cleaners | 33.6 | 13.4 | 13.5 |
| Water Heaters (Flat Rate) | 10.6 | 3.3 | 4.0 |
| Water Heaters (Metered) | 9.7 | 2.0 | 2.0 |
| Grates | 7.3 | 0.8 | 0.7 |
| Heaters | 31.1 | 7.6 | 9.1 |
| Ironing Machines | 2.6 | 1.2 | 1.1 |
| Irons | 99.8 | 72.1 | 76.6 |
| Refrigerators | 18.7 | 12.1 | 11.8 |
| Toasters | 62.1 | 49.7 | 51.4 |
| Blowers & Burners | 5.2 | 1.7 | 1.6 |
| Radios | 79.7 | 68.8 | 70.3 |

TABLE No. 6

SUMMARY OF ESTIMATED NUMBER OF APPLIANCES IN USE BY RURAL CONSUMERS, 1937 AND 1938

| | HAMLET | | | | FARM | | | |
|---|---|---|---|---|---|---|---|---|
| | 1938 | | 1937 | | 1938 | | 1937 | |
| | No. of Appliances | Per Cent of Saturation | No. of Appliances | Per Cent of Saturation | No. of Appliances | Per Cent of Saturation | No. of Appliances | Per Cent of Saturation |
| **IN THE BARN** | | | | | | | | |
| **ELECTRIC** | | | | | | | | |
| Motor | 1,753 | 3.7 | 1,707 | 3.9 | 7,650 | 16.7 | 6,462 | 17.0 |
| Pump | 517 | 1.1 | 551 | 1.2 | 6,125 | 13.3 | 4,939 | 13.0 |
| Grain Grinder | 8 | .... | 11 | .... | 2,488 | 5.4 | 2,087 | 5.5 |
| Milking Machinery | 6 | .... | 6 | .... | 1,317 | 2.9 | 986 | 2.6 |
| Milk Cooler | ..... | .... | 2 | .... | 800 | 1.7 | 553 | 1.5 |
| Cream Seperator | 58 | 0.1 | 19 | ..... | 3,070 | 6.7 | 2,356 | 6.2 |
| Churn | 9 | .... | 8 | .... | 496 | 1.1 | 367 | 1.0 |
| Incubator | 49 | 0.1 | 49 | 0.1 | 537 | 1.2 | 419 | 1.1 |
| Brooder | 42 | 0.1 | 23 | .... | 469 | 1.0 | 322 | 0.8 |
| Hot Bed | 12 | .... | 10 | .... | 35 | 0.1 | 39 | 0.1 |
| Water Heater F.R. | 3 | .... | 6 | .... | 84 | 0.2 | 55 | 0.1 |
| Water Heater Met. | 2 | .... | 1 | .... | 47 | 0.1 | 47 | 0.1 |
| Miscellaneous | 483 | 1.0 | 356 | 0.8 | 467 | 1.0 | 453 | 1.2 |
| **IN THE HOME** | | | | | | | | |
| **ELECTRIC** | | | | | | | | |
| Range | 5,944 | 12.5 | 4,992 | 11.3 | 7,899 | 17.2 | 6,462 | 17.0 |
| Hot Plate | 11,095 | 23.4 | 9,600 | 21.6 | 9,977 | 21.7 | 8,300 | 21.8 |
| Washer | 21,337 | 44.9 | 18,599 | 41.9 | 26,241 | 57.2 | 21,909 | 57.5 |
| Vacuum Cleaner | 6,393 | 13.4 | 5,365 | 12.1 | 6,175 | 13.5 | 4,859 | 12.8 |
| Water Heater F.R. | 1,561 | 3.3 | 993 | 2.2 | 1,821 | 4.0 | 1,281 | 3.4 |
| Water Heater Met. | 956 | 2.0 | 781 | 1.8 | 913 | 2.0 | 637 | 1.7 |
| Grate | 400 | 0.8 | 340 | 0.8 | 344 | 0.7 | 288 | 0.8 |
| Air Heater | 3,594 | 7.6 | 3,379 | 7.6 | 4,153 | 9.1 | 3,748 | 9.8 |
| Ironer | 593 | 1.2 | 402 | 0.9 | 506 | 1.1 | 459 | 1.2 |
| Irons | 34,230 | 72.1 | 30,142 | 68.0 | 35,141 | 76.6 | 28,672 | 75.3 |
| Refrigerator | 5,723 | 12.1 | 4,177 | 9.4 | 5,428 | 11.8 | 3,786 | 9.9 |
| Toaster | 23,639 | 49.7 | 20,642 | 46.6 | 23,543 | 51.4 | 19,941 | 52.4 |
| Radio | 32,677 | 68.8 | 28,237 | 63.7 | 32,224 | 70.3 | 26,090 | 68.5 |
| Furnace Blower | 822 | 1.7 | 678 | 1.5 | 742 | 1.6 | 540 | 1.4 |
| Pumps | 5,423 | 11.4 | 4,781 | 10.8 | 6,977 | 15.2 | 5,603 | 14.7 |
| Miscellaneous | 1,927 | 4.1 | 1,371 | 3.1 | 1,518 | 3.3 | 1,018 | 2.7 |
| No. of Consumers | 47,500 | | 44,340 | | 45,841 | | 38,074 | |




# Port Arthur Welcome Sign

TO commemorate the visit of Their Majesties King George and Queen Elizabeth to Port Arthur on May 23rd, 1939, the Public Utilities Commission of the City of Port Arthur erected an illuminated welcome sign on May Street, at the boundary between Port Arthur and its neighbouring city, Fort William. May Street is the principal inter-city thoroughfare and the main traffic artery for visitors from the United States.

The two sign boxes are 50 feet long by 8 feet high and are of galvanized steel, with all seams soldered and rivetted and the complete boxes enamelled. The clock dial on each sign face is 5 feet in diameter, with numbers on sectional opal glass for illuminating and a solid plate glass, outer, hinged face for protecting the hands.

The supporting columns are of structural steel, spaced 44 feet on centres and carried on reinforced concrete piers. The piers were carried to an elevation four feet above the pavement to provide protection against damage from vehicular traffic and are each supported by four driven spruce piles, thirty feet in length. The clearance between the bottom of the sign and the pavement is twenty feet.

The main wording letters on the sign are 30 inch painted size with 24 inch Neon, and the secondary letters 24 inch painted and 18 inch Neon in size. Tube for all lettering is single red Neon. Decorative tubing for the clock borders is green fluores-

cent. The Neon sign lettering operates directly from the street lighting system and a special service has been provided for clock operation and illumination. Lamps for lighting the dial are back of the opal glass and also provide heat for the clock mechanism during the winter months.

# Who Invented the Telescope?

THE Telescope, undoubtedly, is a development of: "Those glasses they call spectacles, lately invented (1289) to the great advantage of poor old men when their sight grows weak".

Commemorative postage stamps of the islands of St. Kitts and Nevis show Christopher Columbus (1492) using a telescope. This, however, is seriously in error as to date.

According to the earliest records, the telescope was invented in 1608 by Jan Lippershey, a spectacle maker of Middleburg, in Zealand, and a native of Wesel.

The first telescopes were refractors and consisted of an ordinary convex lens, such as was used in the spectacles for the aged, and a concave lens suitable for short-sightedness. The magnification was not more than three or four diameters.

These early telescopes were used to view earthly objects only. Galileo, however, grasping the principles, constructed a more perfect instrument and, in 1610, turned it toward the sky. He discovered spots on the sun, mountains on the moon, four satellites revolving around Jupiter and also that Venus had phases, Mars changed its shape and Saturn had appendages which later turned out to be rings.

The reflecting telescope, after several unsuccessful trials, apparently was first put into usable form by James Gregory, about 1663. In this construction he used a perforated parabolic mirror with a small elliptical mirror to return the image through the perforation to the eyepiece. The observer looked in the direction of the object, as in a refracting telescope, not in the reverse direction or at the right angles as in some later reflectors.

About 1773, Chester Moor Hall, a gentleman of Essex, designed the first achromatic telescope,—not having colour distortion,—with an objective (front) lens of crown and flint glass, and he had it built by George Bast of London. This invention made no impression, however, until it was again brought forward and patented by John Dollond in 1758.

The first equatorial mounting was made by James Short, in 1749. It was fitted with four graduated circles each having suitable tangent screws for adjustment.

It is not known who first applied the star diagonal (right angle reflecting prism) to a telescope but Sir John Herschel, about 1834, modified this device so that it could be used conveniently for observing the sun

without danger or discomfort to the eyes by by-passing about ninety-five per cent of the sunlight so that ordinary eye-pieces with colour screens could safely be used.

The improvements in the parts of earlier telescopes, for example, special eye-pieces to give broader flat fields, and various attachments such as the clock-drive mechanism to follow celestial bodies as the earth rotates, the spectrograph by means of which the composition and radial velocity of a star may be determined, and the polarizing photometer whereby stars may be compared as to colour and intensity, have come down to the present with many inventors' names attached to give us the modern efficient and very flexible telescopes of both the refracting and reflecting types.

The tendency to-day is to build instruments still larger so as to collect still more light, see faint stars better and observe celestial bodies which are farther and still farther away.

# C.E.S.A. Specification For Galvanized Steel Wire Strand

A COPY of the second edition of the Canadian Engineering Standards Association Standard General Specification for Galvanized Steel Wire Strand, No. B12-1939, has been received. The first edition, published in 1924, was the result of a suggestion to the Association by officers of the Bell Telephone Company in 1920 as to the desirability of obtaining as wide agreement as possible on a specification covering the various sizes of galvanized steel wire strand. Enquiries at that time showed that buyers in Canada were calling for over thirty different varieties of this product and it was felt that upon consideration this number could be no doubt substantially reduced, with benefit not only to the purchasers, but also to the manufacturers. It was also found that the materials employed by the manufacturers in filling a majority of their orders could be classed under three grades, namely, a low carbon steel wire ranging in tensile strength from 70,000 to 75,000 lb. per square inch; a wire of similar material the smaller sizes of which showed an ultimate tensile strength up to 120,000 lb. per square inch; and an annealed "crucible" steel wire of higher carbon content, of which the smaller sizes had a tensile strength as high as 210,000 lb. per square inch.

Only a small number of the existing specifications were found to call for materials not included in the above classification and it was, therefore, decided to retain these grades of material for the standard varieties of strand, which with possible modification and the understanding that it will be necessary for purchasers to order specially the strand required for unusual or difficult construction, which cannot, therefore, be regarded

as falling within one of the standard classes.

Since the issue of the original C.E.S.A. specification, some of the larger users of guy strand have found it possible to modify their requirements in some details. Their differences, it was felt, could be reconciled and a new and up-to-date specification prepared acceptable to the principal consumers and manufacturers. In an effort to arrive at a satisfactory specification which would be acceptable to manufacturers as well as consumers, a very large percentage of Canadian users were represented on the Committee along with representatives of practically all Canadian manufacturers.

The specification is now re-arranged to a more natural sequence of clauses. Adjustments have been made in the table of sizes and strengths. In the first edition wire sizes were specified by N. B. S. gauge. This unsatisfactory method has been changed in the second edition and wire sizes are now being stated in decimals of an inch. Test methods have been modernized in technique and requirements of the finished material. Identification is effected by painting a band on the inside of each coil according to a colour code. Left-hand lay has been standardized in the 1939 specification. Appendices describing methods for the determination of the weight and of uniformity of the protective zinc coating have been included for convenient reference.

# The New Edition of the Canadian Electrical Code

By E. W. McLeod, Assistant Approvals Engineer, H.E.P.C. Laboratory

IN order to capitalize on field experience and keep abreast with progress in the electrical industry it is necessary to issue periodically revised editions of the Canadian Electrical Code, Part I, which covers Essential Requirements and Minimum Standards for Electrical Installations. The 4th edition has recently been issued superseding the 1935 edition.

The C.E. Code is sponsored by the Canadian Engineering Standards Association. In the preparation of material for the Code the Commission, (along with other utilities, inspection groups, manufacturers, etc.), co-operates with the Canadian Engineering Standards Association and while in many instances there may be marked divergence of opinion when revisions are proposed eventually through the co-ordinating and co-relating efforts of the Canadian Engineering Standards Association committees these are ironed out to the point where the rules are believed to be practicable and to the satisfaction of the majority at least of interests concerned. Proposed changes in the Code are carefully scrutinized by the various committees of the Canadian Engi-

neering Standards Association working on revisions. Some of the changes may be found to decrease costs, others may increase costs but the former have been adopted in the belief that safety will not be sacrificed while the latter have been incorporated in the new edition because the advantage gained for safety is deemed to warrant any additional cost which may be involved. In compiling the Code every effort is put forth to formulate rules for safe-guarding the use of electricity.

This current issue has many advantages over the 1935 edition. Care was taken, as far as was possible, to so word the rules that the meaning intended will be conveyed to those using the Code so that it will be uniformly understood and applied throughout the country. Rules in the former Code which were found to be unworkable have not been included in the new Code and rules have been expanded or added to cover sound engineering practices which heretofore have been recognized though not specifically covered in previous editions. This has resulted in a somewhat more voluminous edition than previous editions but it should be noted that the greater number of pages is not entirely due to a larger number of rules but to the addition of three appendices and an index for convenience in locating rules. The appendices outline in detail the procedure for compiling the Code and also the means for securing revisions of the Code during the interval between dates of issue of editions (usually three or four years). Revisions are sometimes necessary due to progress in the electrical art or the presence of some unworkable rule, etc. A procedure is outlined for securing interpretations of rules in which there may be ambiguity or lack of clarity. The procedure used in preparing specifications covering examination and test of electrical equipment is outlined. These specifications form Part II of the C.E. Code as issued by the Canadian Engineering Standards Association and used by Approvals Laboratories in determining whether or not electrical equipment is eligible for approval. The method of resuscitation from electrical shock, drowning, etc., is incorporated in one of the appendices.

A brief summary of the outstanding changes is outlined below.

### Rearrangement of Sections

The former Section 8 has been divided into two sections, 7 and 8, the former covering control equipment and the latter protective equipment for electric circuits, machines and apparatus.

There are four new sections, namely, 33—Garages and Service or Filling Stations, 34—Where Excessive Moisture or Corrosive Liquids or Vapours are Present, 35—Motion Picture Studios and Projectors, and 52—High-potential Luminous Discharge Tube Installations. The material in these new sections was drawn mostly from Sections 20 and 32 of the former Code. Section 32 is now restricted, exclusively, to rules covering locations where highly flammable gases and liquids, combustible dusts and easily ignitible fibres are present. This section covers, therefore, such locations as dry cleaning establishments, paint

spray booths, grain elevators, starch plants, sugar and coal pulverizing plants, etc.

Section 37—Radio Installations, has almost disappeared as it is intended that the rules formerly in this Section will appear in Part IV of the C.E. Code,—Rules for the Suppression of Radio Interference, now in the course of preparation.

### Scope of the Code Extended

The scope of this edition has been extended to include all potentials from 0 volts up indefinitely, whereas formerly the range was 0 to 5000 volts.

### New Approvals Authority

According to the new definition of "Approved" the Canadian Engineering Standards Association will be the approvals authority with power to designate testing laboratories to examine, test and report on electrical equipment and apparatus on which approval is requested. Approvals will be issued in the name of the Canadian Engineering Standards Association and it is anticipated that the various inspection authorities throughout the Dominion will accept C.E.S.A. approvals. Approvals of the National Research Council, the Approvals Laboratory of The Hydro-Electric Power Commission of Ontario and Underwriters' Laboratories, Inc. in the U.S.A. were formerly recognized.

### Service Entrance Cable

Several types of service entrance cable are now recognized in Section 4 of the Code as an alternative to the well-known rigid conduit stand pipe construction. It is claimed that this will reduce costs of services.

### Provision for Adequate and More Flexible Wiring

The Code now recognizes wiring systems known as multi-outlet assemblies in which convenience outlets are provided at frequent intervals thus affording a means of easily plugging in portable lamps, appliances, etc. In single-family dwellings kitchens are required to have at least one 1000-watt convenience outlet. A convenience outlet in an electric range meets this requirement.

Demand factors for feeders supplying electric ranges have been revised in accordance with the findings resulting from a detailed study of conditions both in Canada and the United States. Requirements have been added calling for the provision of a larger number of watts per square foot of floor area for lighting loads.

### Changes Affecting Appliance Manufacturers

Several new types of flexible cord have been recognized and the current-carrying capacities of No. 18 and No. 16 B. & S. Gauge cords have been substantially increased thus permitting appliance manufacturers to use a smaller supply cord with resulting decrease in cost and a more attractive article. The maximum permissible ampere rating of attachment plug caps has been increased and this may eventually result in the tandem blade cap becoming obsolete. Convenience outlets are no longer required to have the so-called T-slots as either T-slots or parallel slots will be recognized.

Portable appliances which are required to have a grounding conductor in the flexible supply cord for ground-

ing non-current-carrying metal parts are listed and it is anticipated that this list will prove to be of particular value as a guide to manufacturers and inspection authorities.

### Rules for Grounding

In the former Code ohmic values of resistance were included in the definitions of various terms associated with the grounding of systems, equipment and apparatus but the ohmic values specified now appear in the rules where it was thought they properly belong. These rules have been the subject of much study before being adopted and it is believed that a practicable set of rules has resulted. Various types of grounds are recognized with the full realization that locality has a profound bearing on the type of ground which it is reasonably safe to provide and accept.

### High-potential and Sub-station Installations

Rules governing these installations have been considerably extended and clarified and have been given particular attention by utilities and inspection authorities. Rules for installation of transformers, capacitors, etc., and for the construction of transformer vaults and the installation of high-potential equipment have received particular attention in their drafting. Considerable detail has been added to that contained in the former Code and the rules now cover the best modern practice in safeguarding both the equipment and those qualified or called upon to operate it.

### Explosion-proof Equipment

This type of equipment is now definitely specified for those locations where there is likelihood of an explosion resulting from the presence of flammable volatile liquids, gases, etc. The provision of this type of equipment will undoubtedly result in increased cost of electrical installation where the hazards referred to exist but when viewed from the angle of potential hazard to both life and property involved in such locations, the additional cost resulting from rules requiring this equipment appear to be warranted. Disastrous fires with loss of both property and life are on record where explosions have started the destruction and it is contended that these would have been avoided if the proper explosion-proof equipment had been installed.

In conclusion, space does not permit to discuss in detail all of the changes in the new Code but it would be well to understand that insofar as is practicable the rules now cover modern practice in the electrical art and it is believed that they will furnish valuable guidance not only to the inspector in the performance of his duties as such, but to the manufacturer, jobber and contractor in so far as he is vitally concerned in this phase of his business.

* * * * *

Copies of the Canadian Electrical Code, Part I, may be obtained from Col. W. R. McCaffrey, Secretary, Canadian Electrical Standards Association, National Research Building, Ottawa, or from Mr. A. G. Hall, Chief Electrical Inspector, The Hydro-Electric Power Commission of Ontario, 620 University Ave., Toronto. Price 50 cents.—Editor.

# A.M.E.U. Nominations For 1940

THE scrutineers' report on the primary ballot giving nominations for officers for the year 1940 of the Association of Municipal Electrical Utilities shows the following nominated for the various offices. The names are listed in the order of the number of nominating votes received by each. These nominations are subject to the wishes of the nominees, but the names marked with an asterisk (*) are those which according to the scrutineers' report would appear on the election ballot, providing there are no withdrawals.

### PRESIDENT

A. B. Manson*, G. E. Chase*, O. C. Thal.

### VICE-PRESIDENT

C. E. Brown*, H. R. Hatcher*, A. W. Bradt, W. E. Reesor, V. A. McKillop, A. L. Farquharson, W. R. Catton, J. W. Peart, E. V. Buchanan, C. C. Folger, R. H. Martindale, M. W. Rogers, P. B. Yates, A. B. Manson, S. W. Canniff, R. B. Chandler, Stewart Watt.

### SECRETARY

S. R. A. Clement*, S. E. Preston, F. A. Archer*.

### TREASURER

S. E. Preston*, G. E. Conn*, F. A. Archer, H. T. McDonald, D. J. McAuley, J. W. Peart.

### DIRECTORS

(from the membership at large)

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### DISTRICT DIRECTORS

#### NIAGARA DISTRICT

V. A. McKillop*, H. R. Hatcher, O. M. Perry*, A. W. Bradt, T. R. C. Flint, J. G. Archibald, O. C. Thal, A. E. Ditchburn, R. S. Reynolds, C. A. Veigel, Stewart Watt, George Boucher, J. W. Peart, V. S. McIntyre, George Hancock, W. D. Stalker, A. G. Peirson, C. E. Kirkby, J. F. Hertel, A. D. Stewart, Dr. J. S. Boyd.

#### CENTRAL DISTRICT

G. F. Shreve*, O. H. Scott, W. E. Reesor*, C. C. Folger* and R. O. Quick* (Tie), H. L. Pringle, H. B. Tulley.

#### GEORGIAN BAY DISTRICT

R. S. King*, J. R. McLinden*, C. E. Brown.

#### EASTERN DISTRICT

S. W. Canniff, R. J. Smith*, A. L. Farquharson*.

#### NORTHERN DISTRICT

No nominations.

Up to the time for going to press the following nominees have withdrawn their names:—G. E. Chase and O. C. Thal have withdrawn as candidates for the office of President. This makes A. B. Manson's election by acclamation. F. A. Archer does not wish to stand for Secretary which leaves the present occupant alone for that office. O. H. Scott's withdrawal as Director from the membership at large brings C. E. Schwenger in as a candidate. W. E. Reesor and C. C. Folger have withdrawn their names as running for District Director, Central District and A. L. Farquharson as representing the Eastern District. This latter makes R. J. Smith's election by acclamation.

The elections will be held at the winter convention of the Association at Toronto on February 6th and 7th, 1940. The ballots will be distributed during the morning of the first day of the convention and up to the opening of the afternoon session on that day. The results of the elections will be announced before that session closes.

## E. B. Brown
## Victoria Harbour

On Friday, October 20th, Victoria Harbour lost one of its most highly respected citizens in the person of E. Byron Brown, who died suddenly while enjoying apparently usual health. Born in Florence, Ontario, 73 years ago he started out on a varied career. In his youth he went west and saw service as a deputy-marshal at Centralia in the State of Washington. He worked with a surveying party in the Rocky Mountains and by the merest chance failed to accompany an original surveying and prospecting party which went to the Klondike and discovered gold. He obtained Marine engineer's papers and was employed on numerous Great Lake boats over a period of years. Thirty-eight years ago he accepted the position of engineer for one of the mills of the Victoria Harbour Lumber Company and while with them served in the same capacity on one of the company's tugs.

For the past 29 years, Mr. Brown was Clerk and Treasurer of the Village of Victoria Harbour. He was also Secretary of the School Board and Board of Health for many years, and also Police Magistrate. When in 1914 Victoria Harbour contracted with The Hydro-Electric Power Commission for power, Mr. Brown was appointed Secretary-Treasurer of the local Light and Power Committee, where he served up to the time of his death.

Mr. Brown had a wide reputation for efficiency as a public servant and had a host of friends in the country and throughout the province. He was a deep student of history and an authority on Municipal law. He was also a keen horticulturist. His relations with the Hydro have always been most cordial and he was held in the highest esteem by all members of the staff whose good fortune it was to come in contact with him. The large attendance at his funeral indicated the respect with which he was regarded throughout the village and surrounding community.

# THE BULLETIN

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# Electric Arc Furnaces

By John Young, Manager, Volta Manufacturing Co., Limited, Welland

THE birth of the electric arc furnace, as applied to the melting of iron, was in the year 1878 when William Von Siemens using a small crucible containing the charge introduced into it two carbon electrodes and passing electric current through them melted the charge. From this experiment until DeLaval patented his furnace for refining iron in 1892 nothing much was done. The steel makers were averse to the melting of steel by electricity, the basic open hearth had been developed and electric power was costly.

However, the development of the electric furnace was not arrested inasmuch as the inventors looked to other fields and during those years between 1888 and 1894 Heroult developed electric furnaces for the production of aluminum, calcium carbide and ferro alloys. In the years around 1898, through the development of water power and cheap steam generated power, an impetus was given to the development of electric furnaces for making steel. There was the Stansano furnace, the Kjellen furnace and the Heroult.

These three furnaces, though designed for the same purpose, were entirely different in the methods used. The Stansano was a 3-phase furnace, of the suspended arc type, the electrodes being supported in a horizontal plane above the charge. The Kjellen was an induction furnace. The Heroult was a furnace with the arcs in series, the electrodes being suspended in a vertical position. Of the three types developed the Heroult remains and has been accepted as the ideal and most practical. Of course, there have been several other inventions, coming in at a later period, such as the Snyder, the Greaves Etchell, Girod, etc., but these, for practical reasons, have been dropped, so that today the electric furnace for the melting and refining of steel, as

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Presented to Toronto Section, A.I.E.E. on November 10, 1939.

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**Vol. XXVI No. 12**
**December, 1939**



*The purpose of the Bulletin is to furnish information regarding the Hydro-Electric Power Commission; to provide a medium for the discussion of "Hydro" matters and to maintain the co-operative spirit between municipalities, as well as between municipalities and the Commission. Articles of interest are invited for publication.*

accepted by the steel industry, is really a Heroult furnace—that is, the arcs are in series.

For a time great emphasis was put on the passing of current through the hearth, as in the Greaves Etchell furnace, the claim being that by so doing the hearth would be heated up by the current. But when you look at a furnace hearth, and realize the large section, you can readily appreciate that $C^2R$ losses must be relatively small and, on that account, dismissed as a heating agent. This type of furnace has not been successful for another reason. Where the hearth formed an electrode it meant that some form of contact had to be made which would stand up to the hearth temperature. Usually this contact was water cooled, but, even so, it was a source of trouble and, since the furnace efficiency was no better than the Heroult, it has been more or less abandoned, so that today I would not hesitate to say that over 90 percent of the electric furnaces in operation are of the Heroult type.

In the early electric steel melting furnaces the usual secondary voltage was 100 volts. Later developments saw this increased to 200 volts, and more, the higher voltage being used for melting down and the lower for refining the molten steel. In some cases 3, or even 4, secondary voltages may be used during a heat—medium voltage to break down the charge, the high voltage to melt and the lower voltages to do the refining. Naturally, with the higher voltages surges are common and, in order to reduce these to a point where the load is acceptable to the power companies, reactances are used. These reactances vary but about 45 percent is general on the high voltages and reduced reactances for the lower voltages. Most furnace transformers are provided with off-load tap changers, controllable from the control panel. These tap changers are connected to leads brought out of the primary windings. Connections are also made so that the primary can be changed from delta to star. It is interesting to note that the first time that multiple furnace voltages were used on electric furnaces was in the process of making steel direct from Canadian ore. Here we were starting out with a highly resistant charge and it was found that the usual 100

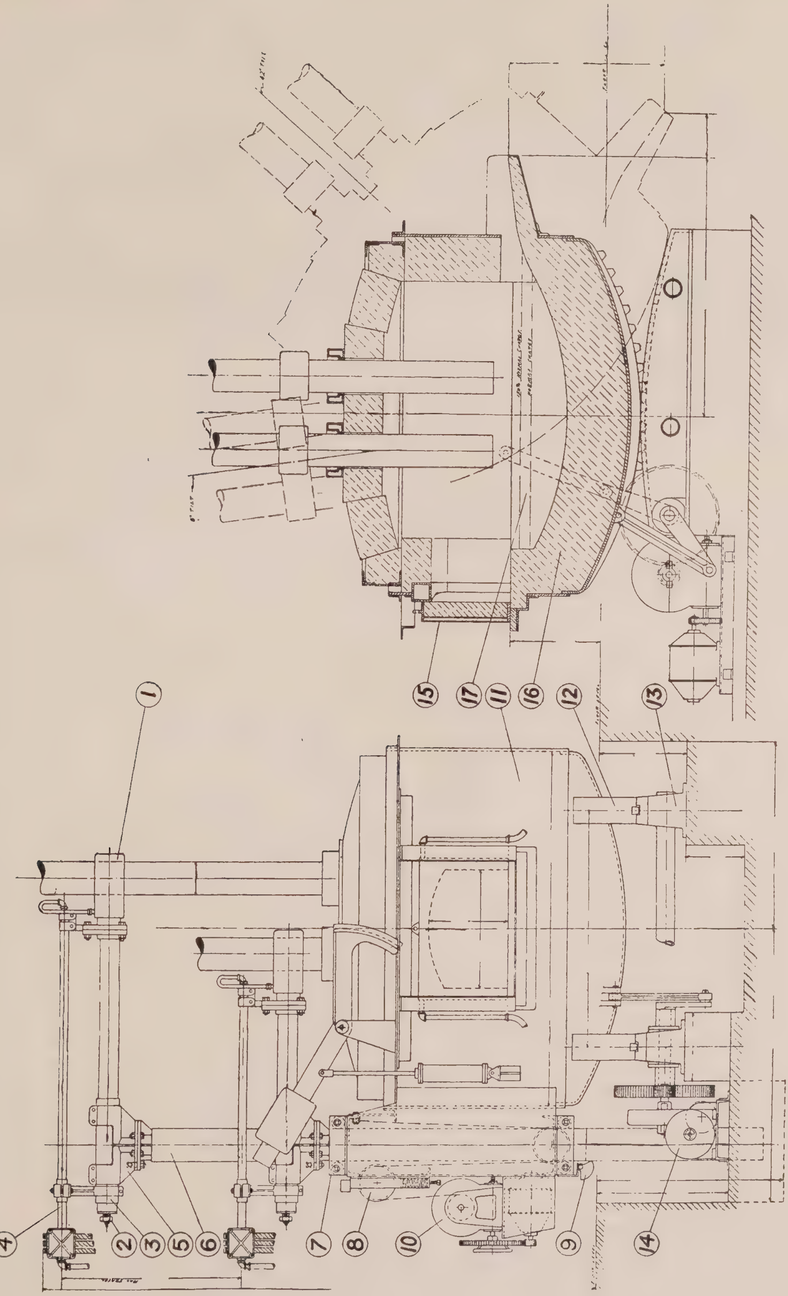


*Fig. 1—Assembly of an electric steel tilting furnace.*

volts secondary voltage could not overcome the resistance of the charge. A higher voltage was therefore used to melt the charge and once a molten bath was obtained the voltage was lowered and the heat finished.

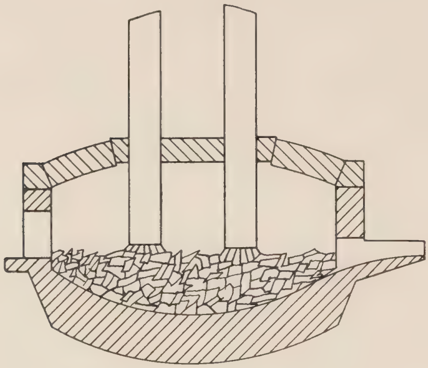

*Fig. 2—Starting up the electric steel melting furnace, arcs playing on steel scrap.*

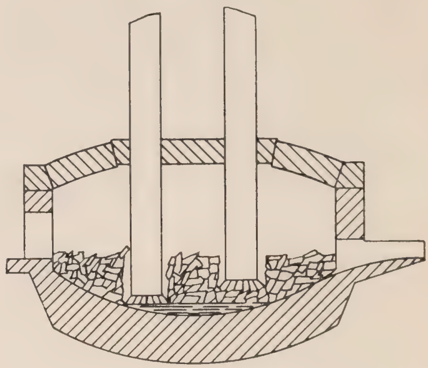

*Fig. 3—Showing the electrodes boring down through the charge, pieces of scrap ready to fall against electrodes to make dead shorts.*

Now let us consider the operation of a modern electric arc furnace. (Fig. 1). The furnace having been charged with steel scrap, the rheostats that control the furnace input are set in the desired position, the electrode raised clear of the charge. Then the oil circuit breaker is closed and the control set on automatic regulation. Immediately, the regulator lowers the electrodes and the arcs are struck. During this period there are violent surges, due to the pieces of scrap continually falling away beneath the electrodes, the electrodes boring into the charge and the upper pieces of scrap falling against electrodes and making dead shorts. (Figs. 2 and 3). Surges are undesirable, both from the furnace operation and power company's viewpoint, hence the use of high reactances and high speed regulators. Moreover, the violence and prevalence of these surges can be reduced to a great extent by care in charging the furnace, seeing to it that the heavy and awkwardly-shaped scrap is put in first and topped off with lighter and more compact scrap. Once a molten bath is made and gases begin to arise around the arc, the furnace settles down with little or no power fluctuations. The actual melting of the steel is done by the arc, any heating by the resistance of the slag to the passing of the current is negligible.

So far I have talked on the electric furnace as used in the production of steel. There are other types of furnaces, however, in general use today, such as those used for the production of ferro alloys, calcium carbide, abrasives, etc. In the electric steel melting furnace the melting agent is the electric arc but in ferro alloys, calcium carbide, abrasives, etc., the melting is accomplished by a combination of arc and resistance, predominately the latter in any good operating furnace since the arc tends to volatalize the charge. The alloy furnace is usually high powered, having anything from 3,000 to 10,000 kv-a. transformer capacity behind it. If the furnace is properly designed it is a very acceptable load to any power com-

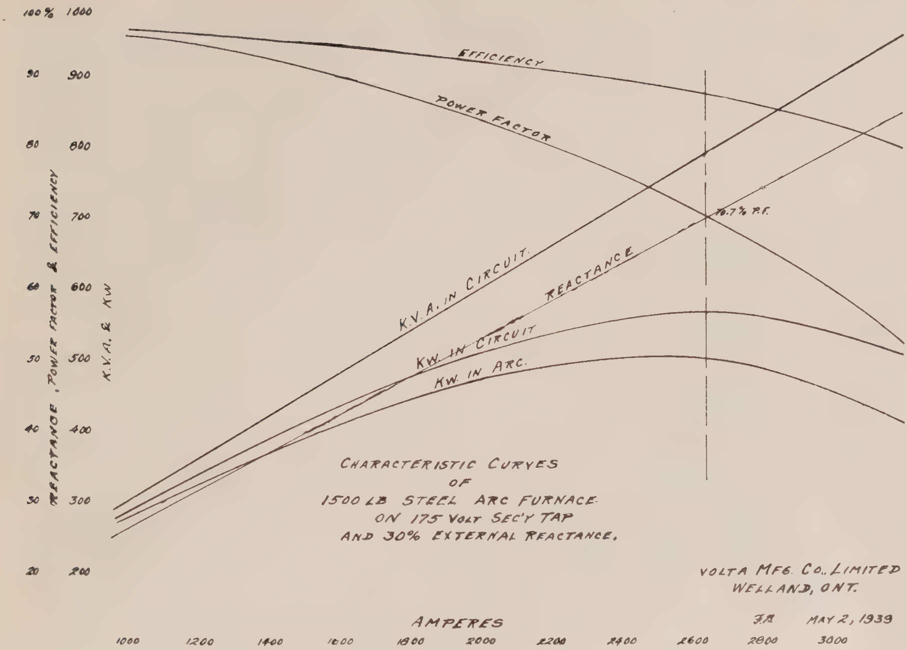


*Fig. 4.*

pany. But if improperly designed, due to the high secondary currents, it may become a most uneconomical load due to poor power factor. (Fig. 4). The handling of the secondary design is one of serious importance if a high power factor is to be the result. The transformer secondaries must be interlaced to as close to the electrodes as is practical. The copper flexibles then become a consideration, for in the mass their conductivity is extremely low, depending on their relative position. To overcome the mass of flexible conductors we are now using water cooled cable conductors and, since we can safely carry four times the current, we have reduced the cable cluster that amount, to the great improvement of the power factor.

In those types of furnaces cycles play a very important part in the design. A design which might be a success on 25 cycles is very often a failure on 60 cycles; also the position of the electrodes in the furnace, whether the three are in line or in triangle. While the three in line may give the best furnace operating conditions there is no doubt the three in triangle give the best electrical conditions. One does not find in the triangle the dead electrode, the nightmare of the three in line. By the dead electrode I mean that one under which there is no melting, and in order to make it melt it is customary to reverse the phases.

The modern electric furnace today is automatically regulated. It may be that regulation is on current variations or it may be on wattage fluctuations. In any case, an effort is made to do this automatically. Now actu-

ally the regulation of electric furnaces is a serious study since there are so many types of furnaces. We build regulators for electric steel melting furnaces, where we regulate on phase current and maintain a balanced arc voltage. We have automatic regulators regulating on current only, such furnaces being of the submerged arc type. Then again we have a type of regulator to suit that type of furnace which is really of the resistance type but where the charge is liable to collapse beneath the electrode and that particular electrode is fed down until it regains its normal current, meantime the other two are stationary. Thus you will appreciate the fact that no one type of automatic regulator meets the requirements of all types of furnaces.

In some types of furnaces of the partial arc and resistance type sometimes the charge in a series voltage will form a bridge between two electrodes. This bridge will suddenly collapse. When this happens no current will pass in one electrode while that in the others will be considerably reduced, and if the regulation is by current only all three electrodes will tend to lower by the action of the current regulator. This causes considerable trouble in the furnace operation and, in order to prevent its happening, a current stabilizer is used and its operation is thus: Just as soon as the charge collapses, and the current goes off, the balance on the stabilizer is destroyed and through the relays the electrode winch motor circuits on the other two electrodes are opened and the motors cease to operate, thus only the one electrode is lowered to establish current in that electrode. This done, the stabilizer once more regains a balance and automatically the other two electrodes come under automatic control.

*Chats Falls power house, downstream side.*

# Furnace Transformers

By Frank T. Wyman, President, The Packard Electric Co., Limited, St. Catharines

A FURNACE transformer is considerably different from the ordinary power transformer for the following reasons:

1. It is usually of fairly large capacity and the secondary has a very low voltage and, consequently, high amperage.
2. Due to the very fluctuating load, often approaching a short-circuit, it must be built very ruggedly to withstand this continuous fluctuation.

Furnace transformers are built with a wide variation of primary voltage all the way from 575 volts to 60,000 volts. One furnace installation now operating has a voltage ratio of 60,000 to 100 volts and has been operating successfully for a good many years. However, the majority of the larger furnace installations have a primary of 13,200 volts.

The majority of furnace installations are of rather large capacity so that invariably three phase transformers or three single-phase transformers are used. In the case of arc furnaces, the three phase installation lends itself admirably to this work as the primary can be connected in delta for the melting down process where a higher voltage is desirable, and then by means of a switch can be thrown into a star connection for cooking or refining process where the lower voltage is more advantageous.

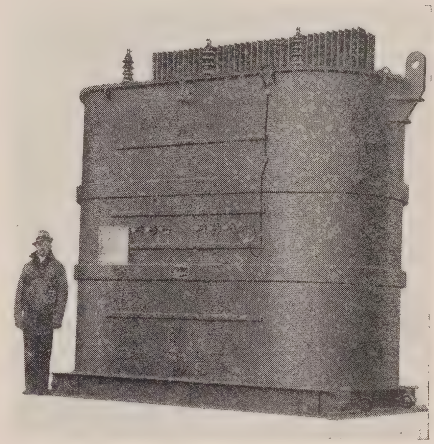

*Fig. 1—A 5,500 kv-a., 3 phase, 60 cycle, 11,000/80-400 volt transformer.*

The secondary of these installations, however, should always be delta connected. Otherwise when the primary is in star we would have a star star connection which is not even desirable on a balanced power load, but certainly is most undesirable on a furnace load where loads on the different phases are at all times varying and might be bad enough to throw a great unbalance on the primary and cause an overvoltage that is not only undesirable on the transmission line but might prove dangerous and cause a breakdown in the transformer itself.

The very low voltage secondary introduces some quite serious problems, as the current in amperes is exceedingly high.

Fig. 1 is a picture of a 5,500 kv-a. three phase, 60 cycle transformer

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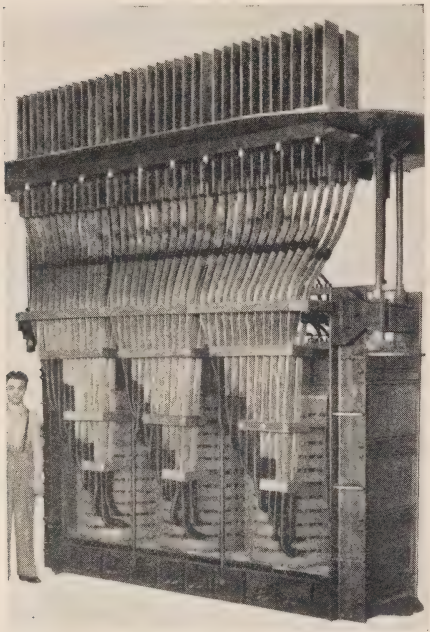


*Fig. 2—Interior view of transformer shown in Fig. 1 showing low voltage leads brought from the coils up through the cover.*

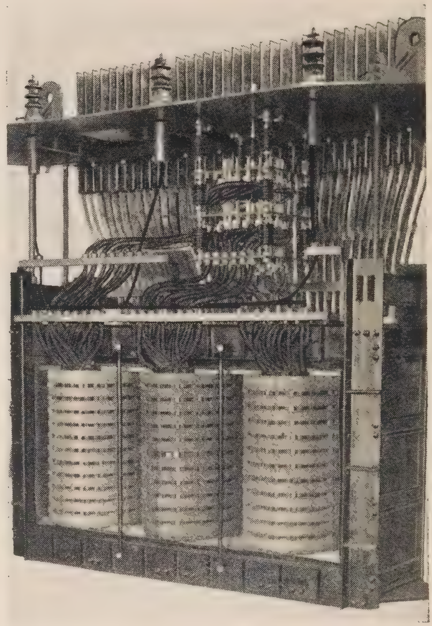


*Fig. 3—High voltage side of transformer shown in Figs. 1 and 2 showing triple deck tap changer switch.*

with a low voltage varying from 80 to 400 volts. Consequently, the amperes vary from 40,000 to 8,000. With this high amperage and at 60 cycles, it is readily understandable that the problem here is not only to wind the transformer to carry this extremely heavy current but also to break it up; that is, intermingle the plus and minus leads in such a manner that there will not be an excessive reactance.

You will note from the illustration the very large number of bus bars required to take care of this current. These bus bars are all alternatively plus and minus. Also, great care must be exercised in keeping all the leads intermingled down to the coils themselves or hot spots might develop in the tank or in the framework of the transformer itself.

Fig. 2 shows the interior view of this particular transformer and how the leads are brought from the coils up through the cover. In this transformer the reactance is approximately 6 percent, which is exceedingly good considering the very high current.

Fig. 3 shows the high voltage side of this transformer, showing the triple deck tap changer switch.

Fig. 4 is a picture of a 3,500 kv-a. three phase, 60 cycle, 13,200/85 to 115 volts, all full capacity in five volt steps.

Fig. 5 shows the interior of this same transformer with the water coils in place.

*Fig. 4—A 3,500 kv-a., 3 phase, 60 cycle, 13,200/85-115 volt transformer.*

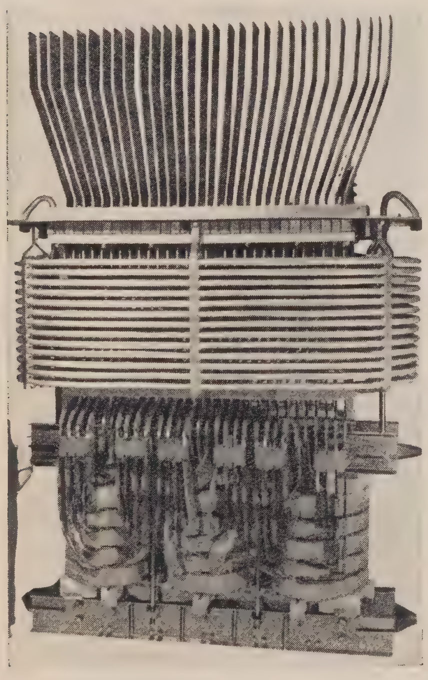


*Fig. 5—Interior view of transformer shown in Fig. 4.*

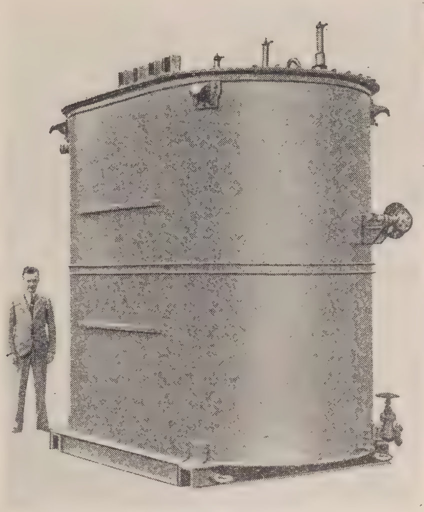


*Fig. 6—A 1,500 kv-a., 3 phase, 60 cycle, 30,000/138 volt transformer with high voltage taps.*

Fig. 6 is a picture of a 1,500 kv-a. arc furnace transformer, 30,000/138 volts with high voltage taps to vary

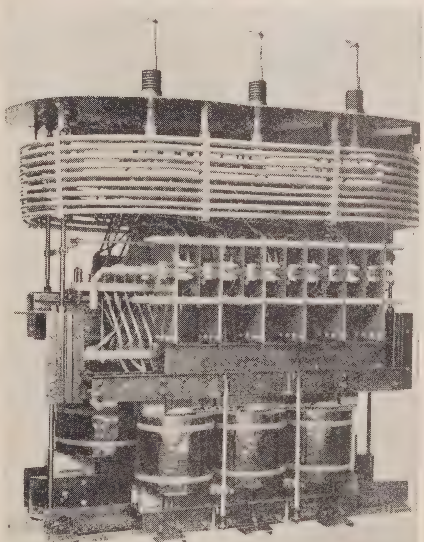


*Fig. 7—Interior view of transformer shown in Fig. 6.*

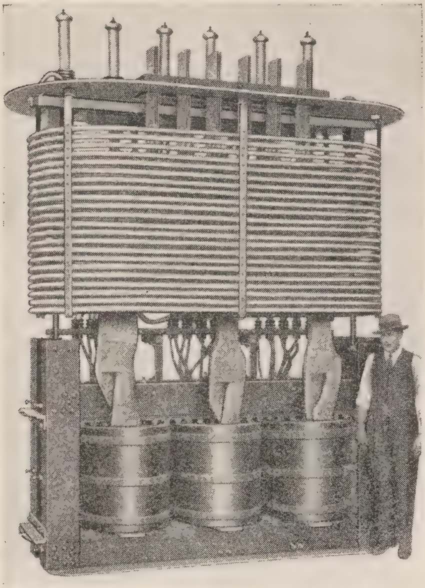


*Fig. 8—A 2,000 kv-a., 3 phase, 60 cycle, 11,500/101-175 volt transformer.*

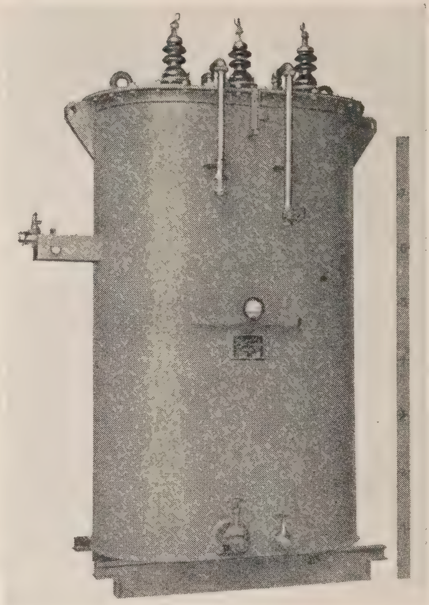


*Fig. 9—A 500 kv-a., 3 phase, 60 cycle, 4,000/157½ volt transformer with high voltage taps.*

the low voltage from 95 to 239 volts.

Fig. 7 is an interior picture of the same transformer. This transformer has a separate reactance of 35 percent.

You will note that this reactance coil is mounted directly in front of the main transformer core and coils. This transformer also has a rotary tap switch with handle extending through the side of the case for remote control, the switch being so arranged that not only the voltages on the main transformer may be changed but also the reactance in the reactance coil in 5 percent steps.

Fig. 8 is a picture of a 2,000 kv-a. arc furnace transformer, primary voltage 11,500 volts with taps to vary the low voltage from 92 to 220 volts.

In this particular installation the separate reactance coil of approximately 35 percent was built and installed separately from the transformer itself.

Fig. 9 shows a picture of a 500 kv-a. three phase, arc furnace transformer, 4,000 volts primary and 157½ volts secondary, with primary taps to vary the secondary from 72 to 192 volts.

Fig. 10 is a photograph of the interior of this transformer and you will note the separate reactance of approximately 35 percent is mounted directly on top of the main core and coils.

Fig. 11 is a photograph of a 250 kv-a. transformer, 60 cycles, single phase, 2,200 volts primary and the secondary varying in voltage from 50 to 220 volts.

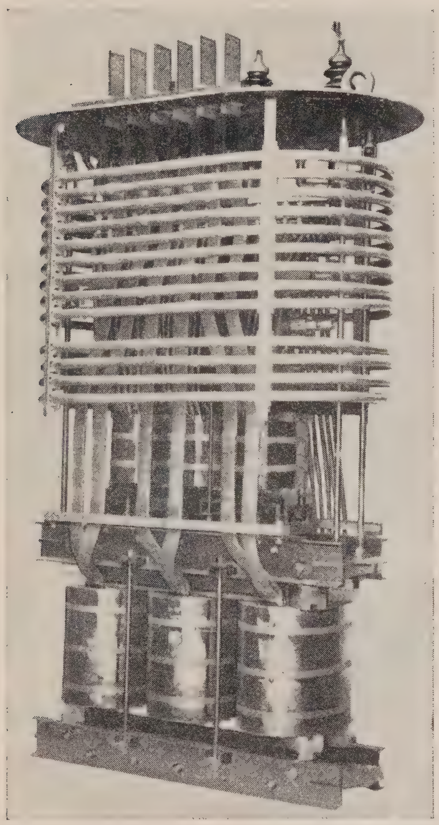


*Fig. 10—Interior view of transformer shown in Fig. 9.*

In this particular transformer the tapping instead of being in the primary is all in the secondary and the voltages are changed by means of the rotary switch, as shown.

This is one of a bank of six used in the manufacture of fertilizer.

I know very little about the actual operation of the manufacture of fertilizer as I have never seen the installation.

Coming down from the sublime to the ridiculous, Fig. 12 is a picture of a 12½ kv-a. furnace transformer

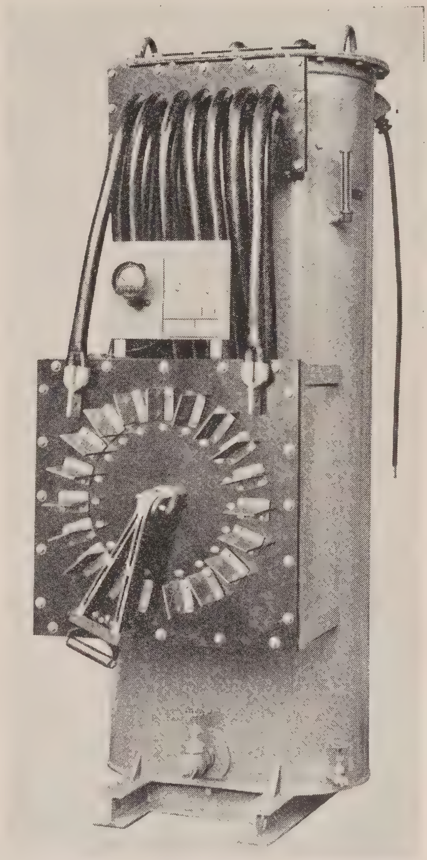
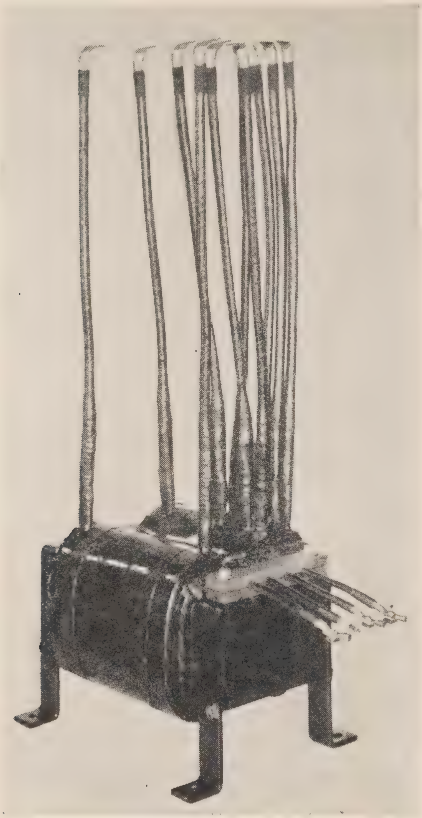


*Fig. 11—A 250 kv-a., 1 phase, 60 cycle, 2,200/220-50 volt transformer with 1,600 ampere tap changer.*

used for annealing, tempering and so forth. The primary is 115-230 volts, or in some cases 575 volts, and, by means of separate coils on the secondary, the voltage range normally is from 2 volts to 46 in two volt steps.

Most furnace transformers are water-cooled as, to start with, they are somewhat cheaper than self-cooled, and, usually it is necessary to have water in the furnace plant for cooling the electrodes; and I believe it is quite common to use the cooling water



as it comes from the transformer to later cool the electrodes.

You will note from the foregoing that there are two major types of furnace transformers. For instance, as shown in Figs. 1 and 2, this particular 5,500 kv-a. transformer is used on a furnace of the resistance type and as this type of furnace is not subject to very severe fluctuations only a normal reactance is necessary.

However, furnace transformers for arc type furnaces must have a very high reactance, usually from 35 to 40 percent, necessitating the separate reactance coils as has been shown in

*Left:*
*Fig. 12—Air cooled, 12.5 kv-a., 60 cycle, 110-230/2-46 volt transformer.*
*Below:*
*Fig. 13—Curves of the mechanical force exerted between the high-voltage and low-voltage coils of a transformer when short circuited.*

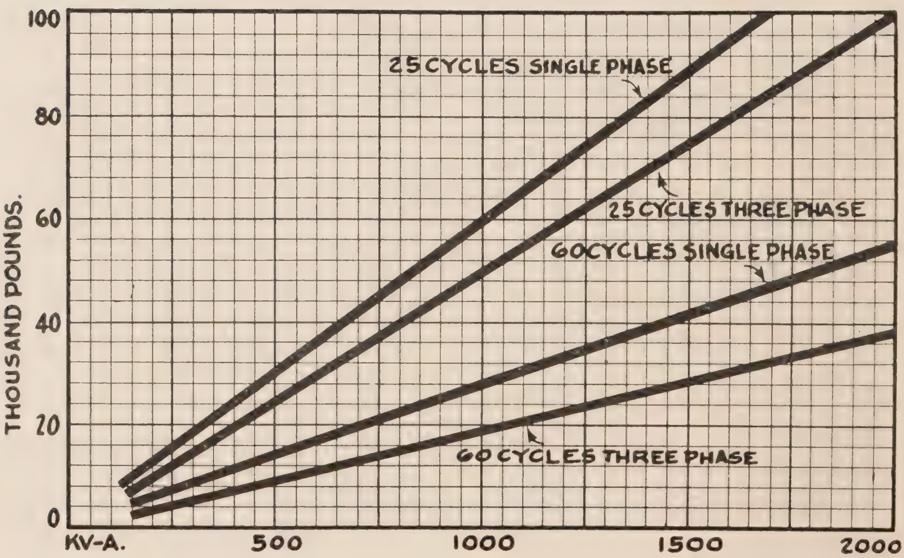


*Fig. 14—Effect of a short circuit on a small transformer.*

the illustrations so that before the arc in the furnace is formed it will limit the current to approximately 2½ times normal. This, of course, is only a momentary load until the arc is formed.

In any furnace operation, the load is subject to wide fluctuations, and, as the load fluctuates, the force exerted on the windings, particularly in a large transformer, reaches high values. This force varies as the square of the current and inversely with the frequency, and as the current varies inversely with the impedance, the mechanical force varies inversely as the square of the impedance.

Fig. 13 shows how tremendous the forces are in a transformer when subjected to a short-circuit. In this particular case, of course, the impedance is only 3 percent, but with this low impedance a 2,000 kv-a. transformer on a sudden short might have a force

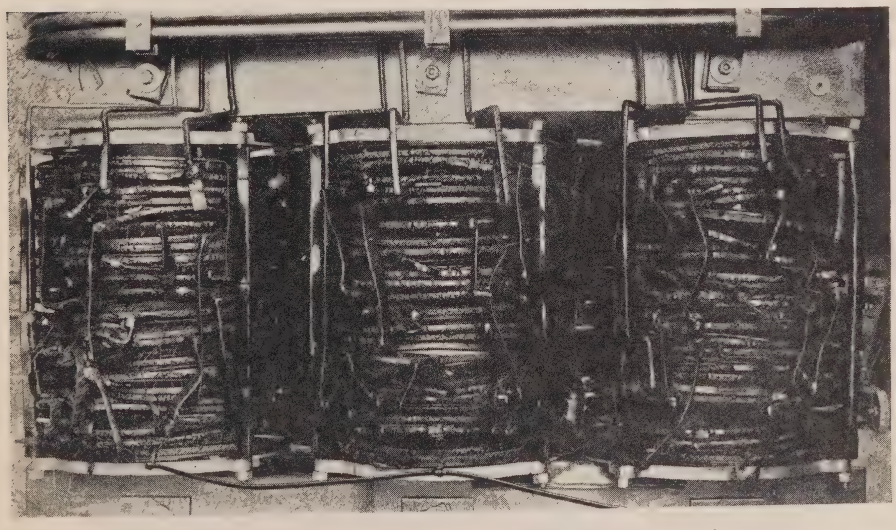


*Fig. 15—Effect of a dead short on an old type transformer.*

exerted of over 100,000 pounds on the windings. While all present day furnace transformers do have a much higher impedance than 3 percent, still on the fluctuations there is a continual variation of force that necessitates a very rugged design to continuously withstand these forces for many years to come. Fortunately, most of the forces in a core type design that are exerted between the primary and the secondary on a sudden change of load are in a horizontal direction. Consequently, if the coils could be so arranged as to be mathematically centred, there would be no end thrust, but this is usually not possible.

Fig. 14 shows what can happen on a short-circuit, even on a small transformer. This is a photograph of a 10 kv-a. 60 cycle, 13,200/2,300 volt transformer. It was subjected to a sudden dead short and the primary endeavoured very hard to hop up over the end frames. While this is a very small transformer, you can understand that the force exerted to do this was a considerable amount.

Fig. 15 is a picture of a very old Packard transformer built some twenty-six or twenty-seven years ago. It had only one dead short on it, and you can plainly see what happened. The pancake coils in some places became quite chummy, and in other places endeavoured to get as far from each other as they could.

The picture does not show the spacers as they were evidently removed before the picture was taken. It had the supposedly usual number of spacers between the pancakes but the force was sufficient between the spacers to distort the coils sufficiently to cause short circuits and the eventual breakdown.

# Putting Hydro to Work on the Farm

By H. J. Edwards, Assistant Engineer, Municipal Engineering Department, H.E.P.C. of Ontario

THE Milton Rural Power District is proud of R. T. Wilson, who lives on the eastern boundary of Milton and puts on a daily demonstration of how to make Hydro work on a farm of 195 acres. Seventeen years ago the service was installed in the house and barn, and the illustration shows what Mr. Wilson has done in his spare time to make the service work for him.

A five horsepower motor bought in 1922 has been operating a work bench lathe, two grinders for sharpening farm tools, a rip-saw, water pump, grain grinder, hay lift, and two grain elevators and distributors in the granaries. Most of the equipment has been assembled from scrap material and installed by Mr. Wilson and it is this feature which is most interesting.

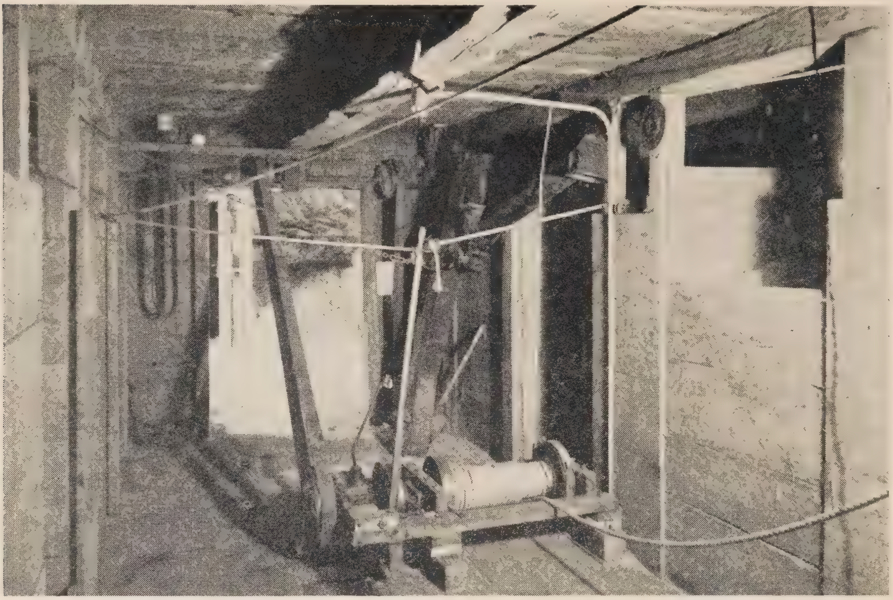
It was a simple matter to belt the Vessott 6½ inch burr plate chopper to the 5 horsepower motor and grind 2,000 bushels of grain per year, but who would think of adding an old steam engine fly-ball governor to the chopper to prevent overloading on the motor.

One experience with some wet grain which plugged the chopper and thereby caused some damage to the motor windings, set Mr. Wilson to contriving a gadget to shut off the current, if a similar accident should occur while he was busy in some other part of the barn. An old steam engine governor was found and installed on the chopper and a cord connection arranged between the governor and the motor switch. After starting the chopper the cord is slipped over the handle of the switch and the arrangement is such that should the chopper slow down due to plugging and overloading the motor or belt drive, the fly-balls allow a weight to drop and pull the switch on the motor. It actually works.

The problem of fine and coarse chop was solved by the installation of a home-made shaker screen which separates out fine pig feed as required.

The pump on the 26 foot well is connected to the line shaft through an old car transmission for speed control, and the pump jack is counterweighted with scrap iron for smooth operation. Water is pumped into a tank of several hundred gallon capacity, with a float so arranged that when the tank is full an old brass sleigh bell is struck by the set screw in the line shaft coupling and signals that it is time to shut off the pump.

The line shaft extends into a work shop where Mr. Wilson repairs equipment and plans new gadgets to ease his labours. The rip-saw installed in a manger roughs out pulleys from plank-



*Hay hoist made from a piece of 5 in. well casing and clutch, transmission and two brake drums of an old automobile. Grain elevator and conveyer in the rear.*

ing and these are turned in the wood lathe or in position on the line shafting.

Upstairs in two granaries is shafting connected to the 5 horsepower motor so that the cleaning and storing of grain is no work at all. The grain runs from the separator, or the fanning mill when used, into elevators which lift it to chutes or a screw conveyer and from there it is dropped into the proper bins.

The hay hoist shown is driven from the granary shafting and delivers hay to any of the three mows in the barn. It was made from a piece of 5 inch well casing, a car clutch and transmission and two brake drums from old cars. Two hand lines control the clutch and brake, and the drum is free running for ease in pulling back the forks. This cost Mr. Wilson about $12.00 for parts and some welding and is a splendid illustration of his handiwork as a farm mechanic.

All grain and fodder grown on the 185 acres under cultivation is fed to beef cattle and pigs and no labor is hired. Mr. Wilson finds that Hydro replaces the hired man and saves money.

Cutting the grass around the house was about the hardest job on the farm until a small motor was belted to the knives on the lawnmower and connected to the yard outlet by a rubber covered extension cord. Mrs. Wilson now finds that guiding the lawnmower is as easy as taking a walk among the pine trees that surround the yard.

A son of 18 and a daughter of 14 years assist in the farm work, but since Farmer Wilson put Hydro to work there is not much for them to do.

# Vagaries of the Earth's Magnetism

MODERN scientists have discovered many facts about the earth's magnetism which are fully as remarkable as the fantasies of the magnetic mountain in the Voyage of Sinbad the Sailor.

There are indeed real "magnetic mountains" consisting of extensive deposits of iron ore; but they cannot produce the effects which some people attribute to them—they cannot pull nails out of ships nor make automobiles run up hill. However, these deposits of iron ore do strongly affect a magnetic compass in surrounding regions. Close to one of these deposits the compass-direction may be completely reversed. Near one such region along the Alaskan coast, the compass loses its directive force and becomes utterly useless as an instrument of navigation.

The magnetic effects of such bodies, although highly concentrated, are relatively insignificant as compared with the magnetic effect of all the substance of the earth. For example, at a distance of a few miles the effect of one of these regions is frequently undetectable, while the earth's magnetic action extends many thousands of miles out into space.

We know that practically all the earth's magnetism is due to causes deep within the earth. In view of this deep-seated nature of the earth's magnetism, it would appear extremely remarkable if any appreciable changes were to occur in it. Yet changes do occur—changes of astonishing magnitude. For instance, scientific observations made at London between about 1600 and 1800 revealed that during this period the compass-direction had changed by over 35 deg.

One is thus encouraged to speculate on how great the changes in compass-direction might be in the course of many thousands of years. Since the compass came into use only a few hundred years ago, we cannot obtain this knowledge from written records; other methods must be found for the acquisition of this important information.

An ingenious method for ascertaining the compass-changes in past ages—even in past geologic epochs—is being employed at the Carnegie Institution's Department of Terrestrial Magnetism. It consists of measuring what might be called the fossil magnetism of rocks in age-old deposits in oceans and lakes. Many sedimentary rocks contain small quantities of magnetic material. As the rocks were formed by particles settling in quiet water, the tiny magnetic particles behaved like compasses and pointed toward what was then the magnetic

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From a G.E. Science Forum talk by Dr. J. A. Fleming, Director, Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D.C.

north. After these miniature compasses settled to the bottom with their north ends north, they were locked into place by other particles falling on top of them. Thus by finding out which direction is indicated by these miniature compasses imbedded in rocks, we can learn the direction of the earth's magnetism at the time the rocks were formed.

The compass-changes that have been mentioned take place slowly—so slowly that many years pass before they become appreciable. But there are also temporary changes which take place much more rapidly. This class of variations includes the daily changes in compass-direction and the erratic, violent fluctuations which, because of their irregular character, are called magnetic storms.

Magnetic storms may occur at any time. Unlike thunderstorms, they occur without any warning. They affect compass-needles all over the world simultaneously. During the past two or three years, magnetic storms have been unusually common because sunspots, which we know are associated with magnetic storms in some peculiar way, have been very numerous.

One of the most violent of these storms ever recorded occurred a year ago last April. Compass-changes amounting to several degrees occurred within an hour. London experienced a change in compass-direction greater than 5 degrees, the largest ever observed there during a storm in 90 years. Accompanying this storm were unusually brilliant displays of the northern lights.

Scientists have known for many years that the primary causes of the compass-changes during magnetic storms have their origin above the earth's surface. Presumably these are electric currents flowing in the high layers of the atmosphere and beyond. If so, these currents amount to millions of amperes during the most severe storms. Calculations of the energy involved in magnetic storms show that during the great magnetic storm of April, 1938, the expenditure of energy was more than 20 times as great as could be supplied by all the electric power plants in the United States working at the same time!

The average man is not directly concerned with electric currents flowing far above his head or brilliant flashes of light in the northern skies, but he is directly concerned with some of the effects of the magnetic storms, for example, the interference with radio tranmission. Radio waves are transmitted over great distances because they are reflected back to the earth by the electrified regions of the upper atmosphere; otherwise, they would pass off into space and not follow the curved surface of the globe. During magnetic storms these upper layers of the atmosphere are greatly affected, with resultant impairment of radio transmission. So close is this connection that radio methods are actually being used to study the changes in the earth's magnetism.

Thus, considering all these things,

one may question whether the fantasies of Sinbad the Sailor and other authors of imaginative tales are really more extraordinary than the real facts which Nature has set before us.—*General Electric Review.*

# Experience With Overhead Shielded Primary Cable

By G. L. Lillie, Assistant Distribution Engineer, Toronto Hydro-Electric System

*(Continued from November)*

The shielding of all aerial cables is connected electrically and mechanically to the common neutral wire at every alternate pole. Five-eighth inch copper ground clamps are ordinarily used, but where the armour is aluminum, special composite clamps are employed.

So very closely related is the development of the transformer mounting at the load end of the cable, with the cable itself, that an outline of its history must be included. Until 1932 transformers on cable extensions were hung on crossarms on 35 foot cedar poles and connected to house lighting secondary bus and to primary cable with weatherproof wire leads (Fig. 26) just as if they were on main line poles. As this transformer pole in each case replaced a concrete and had similar poles on either side of it, we received many complaints about its appearance, both with regard to the pole itself and the transformers thereon. The general public could not see that we had eliminated the need for perhaps four or five other cedar poles with crossarms, but only that we had replaced an inconspicuous pole in front of their house with an ugly one and put some large iron boxes on it. It, therefore, became advisable to improve methods of transformer installation. Either cedar pole mounting had to be made more sightly or transformers erected on concrete poles. The latter was first accomplished in 1932. (Fig. 27.) A modified 28 foot concrete pole was first

*Fig. 26—Two transformers mounted on a 35 ft. cedar pole.*

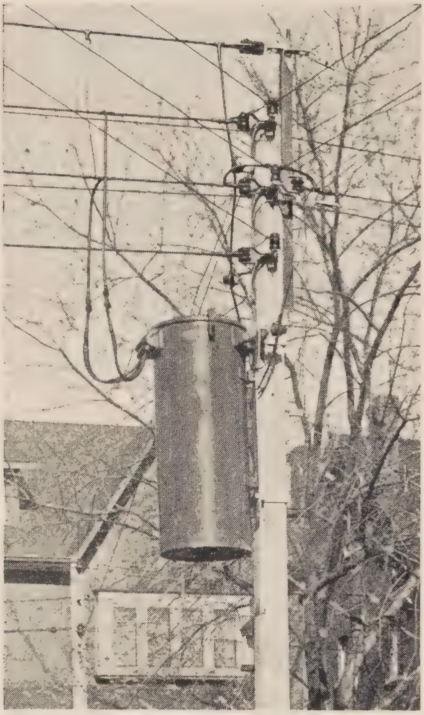

*Fig. 27—Transformer hung on a concrete pole.*

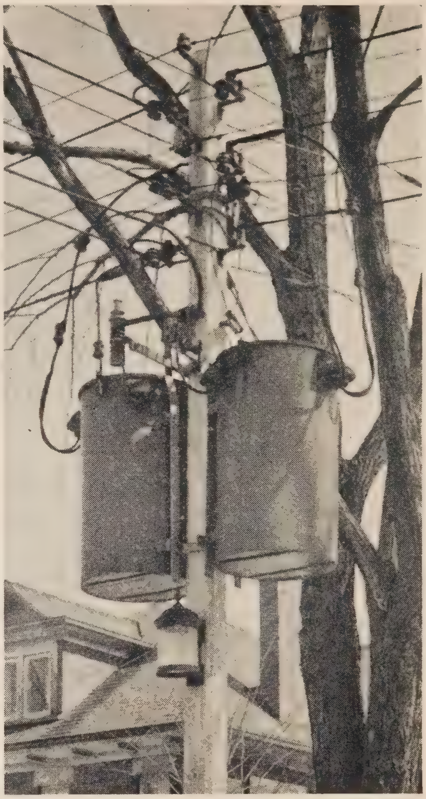

*Fig. 28—Two transformers mounted on a concrete pole.*

used, the only difference being that a hole was cast in the pole to take a through-bolt for supporting steel transformer arms and a ground wire down through the pole was included. Since then 196—25 kw. transformers have been so erected, a standard pole now being used with clamp for holding transformer bracket and the ground wire dispensed with and cases grounded to common neutral only. Until 1937 these transformers were installed singly on adjacent poles. They are now hung on one pole, back to back (Fig. 28), thus lowering costs and eliminating losses in secondary neutral connection between them.

Lightning arresters are not installed on transformers supplied by shielded primary cables. An arrester is required at the line or supply end of the cable, but as there is generally one already at this point, further economy results.

On cedar poles, used for transformer erection in concrete leads, improved methods were also tried. As the wire arrangement on concrete poles is essentially vertical, the horizontal line crossarms were discarded and the cable deadended on the peak of the pole. The shielded primary lead was then run down the face of the pole as previously described, or

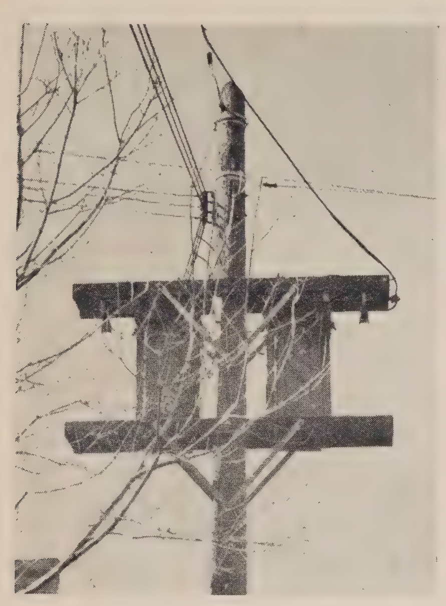

*Fig. 29—Two transformers on a 30 ft. cedar pole.*

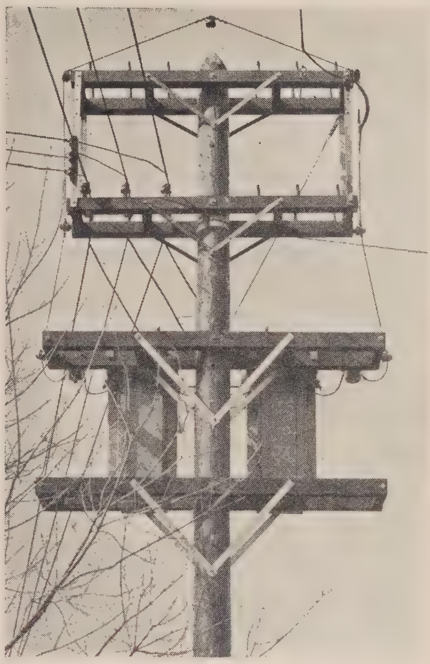

*Fig. 30—Transformer mounting on 35 ft. pole replaced by Fig. 29.*

more directly, using wire cable grips, from deadend to cutout on end of the transformer crossarms. With this arrangement, a 30 foot pole (Fig. 29) can now be used in place of the 35 foot (Fig. 30) previously required, and a much less conspicuous installation results.

As the first types of cable installed were of an experimental nature, it was quite to be expected that some troubles would develop. By their occurrence, we have benefitted, and eliminated weak points in design, installation, and operation. Cutouts are installed at supply end of all cable extensions to isolate and clear possible faults. Where transformers thus supplied, are banked with others on open line construction, no interruption to the consumer results. Should a fault occur in the cable, feed back from secondaries blows the transformer fuses and the cable is thus made dead.

Since 1931, there have been 55 breakdowns necessitating minor repairs. (Table No. 4.) The total cost of this maintenance has been approximately $1,423 over eight years, $177 per annum, or 1.27 per cent of total investment. These faults have occurred in 37 out of 267 installations or approximately 13.5 per cent. In analyzing cause of these breakdowns, it is seen that the majority (22 out of 55) were due to pressure on the insulation due to angles in the line, and that all but three of these took place with one make of cable; which we now know to have a particularly soft insulation. The next largest

TABLE NO. 4
55 FAULTS:—SINCE 1930

| Year | At angle, due to lateral pressure | | | At deadend | | | At joint or splice | | | In mid span, due to apparent injury or defect in cable | | | Apparently due to lightning | | | Due to external mechanical damage | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Due to insufficient clearance between bared conductor and shield | | | | | | | | | | | | | | |
| | No. | Cable | Type | No. | Cable | Type | No. | Cable | Type | No. | Cable | Type | No. | Cable | Type | No. | Cable | Type |
| 1932 | 1 | 82 | 11 | 2 | 92 | 11 | 7 | 91 | 11 | | | | | | | | | |
| | 3 | 80 | 11 | | | | 8 | 91 | 11 | | | | | | | | | |
| | 4 | 73 | 11 | | | | | | | | | | | | | | | |
| | 5 | 87 | 11 | | | | | | | | | | | | | | | |
| | 6 | 93 | 11 | | | | | | | | | | | | | | | |
| 1933 | 13 | 94 | 11 | 9 | 86 | 11 | 12 | 118 | 14 | | | | | | | 19 | 79 | 11 |
| | 14 | 87 | 11 | 10 | 107 | 15 | | | | | | | | | | Caused by | | |
| | 15 | 92 | 11 | 11 | 121 | 14 | | | | | | | | | | wrong type | | |
| | 16 | 93 | 11 | 17 | 120 | 14 | | | | | | | | | | of deadend | | |
| | 18 | 85 | 11 | | | | | | | | | | | | | clamp | | |
| 1934 | 21 | 88 | 11 | | | | | | | 20 | 65 | 11 | 22 | 168 | 16 | | | |
| | 23 | 75 | 11 | | | | | | | | | | | | | | | |
| 1935 | | | | 26 | 119 | 14 | 27 | 118 | 14 | 24 | 189 | 19 | | | | | | |
| | | | | | | | 28 | 92 | 11 | 25 | 184 | 18 | | | | | | |
| | | | | | | | 29 | 184 | 18 | | | | | | | | | |
| | | | | | | | 30 | 24 | 6 | | | | | | | | | |
| | | | | | | | 31 | 122 | 14 | | | | | | | | | |
| 1936 | 33 | 93 | 11 | | | | 32 | 88 | 11 | | | | | | | 34 | 125 | 15 |
| | 35 | 73 | 11 | | | | | | | | | | | | | Caused by | | |
| | | | | | | | | | | | | | | | | falling sign | | |
| 1937 | 38 | 90 | 11 | 36 | 73 | 11 | | | | | | | | | | | | |
| | 39 | 122 | 14 | 37 | 102 | 14 | | | | | | | | | | | | |
| | 40 | 82 | 11 | 41 | 186 | 18 | | | | | | | | | | | | |
| | | | | (bronze clamp) | | | | | | | | | | | | | | |
| 1938 | 46 | 94 | 11 | | | | 43 | 10 | 7 | 44 | 185 | 18 | | | | 42 | 146 | 14 |
| | 47 | 80 | 11 | | | | 45 | 84 | 11 | | | | | | | Caused by | | |
| | | | | | | | | | | | | | | | | falling tree | | |
| | 48 | 80 | 11 | | | | | | | | | | | | | 49 | 110 | 15 |
| | | | | | | | | | | | | | | | | Caused by | | |
| | | | | | | | | | | | | | | | | tree growth | | |
| 1939 | 51 | 181 | 18 | 52 | 243 | 18 | | | | 50 | 182 | 18 | | | | 53 | 71 | 11 |
| | | | | (under wire | | | | | | | | | | | | Same as for | | |
| | | | | grip) | | | | | | | | | | | | No. 19 | | |
| | 54 | 120 | 14 | | | | | | | | | | | | | 55 | 80 | 11 |
| | | | | | | | | | | | | | | | | Caused by | | |
| | | | | | | | | | | | | | | | | falling tree | | |

cause of trouble was due to insufficient clearance between armour and conductor bared in making deadends and joints. These all occurred on strain insulator deadends, except in one case of a bronze clamp deadend, and another of a wire grip. These, excepting the wire grip, are no longer used, though if properly made should give no trouble. Eleven cases of trouble were traced to breakdown between shield and conductor in splices or "Y" joints. With the exception of the occasional line splice, these joints are no longer required. We have had five cases which might be due to defects in material or to injury done during erection. In each case breakdown took place between supports, where there was no apparent possibility of outside mechanical stress after installation. Another puncture we blamed on lightning, and in four other instances, one fault was caused by a falling sign, two by falling trees and fourth by wear of a tree branch. There were also two cases of clamp type grips being installed on tape shielded cable with unfortunate results. With one exception no faults have occurred on any installation made since January, 1935. As lateral stress in angles is now removed, and joints and splices at deadends are out, we consider that not more than 10 of these cases of trouble would have occurred, if cable had been erected under present-day conditions. This would mean a total maintenance cost of approximately $270 for 8 years.

Few tests have been made on cable samples, as manufacturers' guarantees have been considered ample for our needs. In mechanical strength we have found all makes equally satisfactory, medium hard drawn copper usually being employed in tape shielded cable. With wire armour the construction is, of course, even more rugged. Weight per foot has varied from 28 to 40 pounds per 100 feet, depending on the type of shielding used. This is less than No. 0 w.p.t.b. wire (42.5 lb.).

In preparing specifications for the purchase of shielded primary cable, we have been principally concerned in obtaining some common ground for competitive purchasing. Where there are several interested manufacturers, they must be given an equal basis for estimating comparable costs. With this in mind, a definite choice had to be made in the type of insulation, shielding, etc. Varnished cambric insulation had proved quite satisfactory, but with the improvements in rubber, it was decided to concentrate on this for the time at least. Reference was made to the A.S.T.M. requirements and a compromise in the best designs of the various manufacturers was selected.

We call for a seven wire stranded conductor, although solid wire has been used with success. Individual wires are to be medium hard drawn, and tinned. The insulation shall contain not less than 40 per cent of best quality Hevea rubber, which has not been previously used, and shall also conform to the following physical properties: (See top of next page).

The oxygen bomb test is not called for. Thickness of insulation shall be 8/64 inch, minimum thickness to be not less than 90 per cent. of the average. High voltage test is not less

| | Maximum | Minimum |
|---|---|---|
| Tensile Strength, lbs. per sq. inch | — | 2,000 |
| Tensile Strength, at 200 per cent elongation, lbs. per sq. inch | — | 500 |
| Elongation at rupture, per cent | — | 500 |
| —which are greater than called for by A.S.T.M. | | |
| Set in 2 inch gauge length, inches | ⅜ | — |
| Depreciation in tensile strength and elongation after Ceer oven test at a temperature of 157 deg. Fahr. for a period of 96 hours, per cent | 15. | |
| —which is the same as called for by A.S.T.M. | | |

than 10,000 volts for 5 minutes on each reel length of cable, after 12-hour immersion in water. Insulation resistance must be not less than 7,900 megohms per 1,000 feet at 60 deg. fahr.

Over the insulation a closely woven cotton tape, rubber faced on one side and of minimum thickness of .010 inches shall be applied with at least ⅛ inch overlap. The shielding shall consist of 2 soft copper tapes of ¾ inch maximum width and of minimum thickness of .005 inch each, helically applied in the same direction with the outer tape approximately centred over the spaces between the convolutions of the inner tape. Some makes were previously supplied with a fabric tape over the shielding but we have eliminated the necessity of this. An overall braid is called for, of closely woven cotton hawser cord of minimum thickness .050 inch saturated with a preservative coating and finished smooth and free from tackiness. These specifications we consider as a minimum requirement, which will no doubt be improved from time to time.

In conclusion, our experience has been, that non-leaded shielded primary cable, though far from a perfect product, has great possibilities and that for saving, safety and sightliness it serves a very useful purpose in the modern electrical distribution system.

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## Correction

In the article "Who Invented the Telescope", page 349 of *The Bulletin* for November, the year of Chester Moor Hall's work on the telescope should have been given as 1733.

*Airplane view of the Grand Coulee dam under construction. The natural storage basin is in the upper centre.*

# Modern Builders Surpass Old Egyptians

HOLDING in check the mighty Columbia at a point where it flows through a lava-rimmed, 1,600-foot deep chasm, in the State of Washington, the builders of the Grand Coulee dam will dwarf the efforts of Cheops, to whom is accredited the largest of the pyramids at Gizeh, Egypt. A booklet published by Souvenirs Company, Coulee Dam, Washington, entitled Grand Coulee Dam,—The Eighth Wonder of the World—gives data on the construction of the project from which the following have been taken giving an idea of the immensity of the undertaking.

The dimensions of the pyramid, which was built between 3733 and 3700 B.C., are given as covering 13 acres at its base and its original height 482 feet. In comparison to the ancient cathedral of the dead, the Grand Coulee dam will have a base of nearly four times that of the pyramid at Gizeh and the height above the lowest rock will be 550 feet. The top thickness of the dam will be 30 feet along its 4300-foot course. The dam has a footing of 500 feet in

width. Throughout the dam there will be eight miles of galleries to serve for gate inspection and control, drainage, grouting, cooling and other purposes.

The excavation necessary to construct the dam was in excess of 22,000,000 cubic yards of dirt and stone. As the excavation was getting under way, about 33,000 feet of diamond drilling were put down into the granite foundation on which the dam rests. These drillings varied on occasion from 660 to 880 feet. This was necessary to determine the strength of the rock formation and that the bedrock was of uniform character. To seal cracks and crevices in the rock five rows of holes, 30 feet deep and 20 feet apart, alternately were drilled under the upstream side of the dam and completely across the canyon. A grout of cement and water under pressure was then forced down through the drilled holes in the rock.

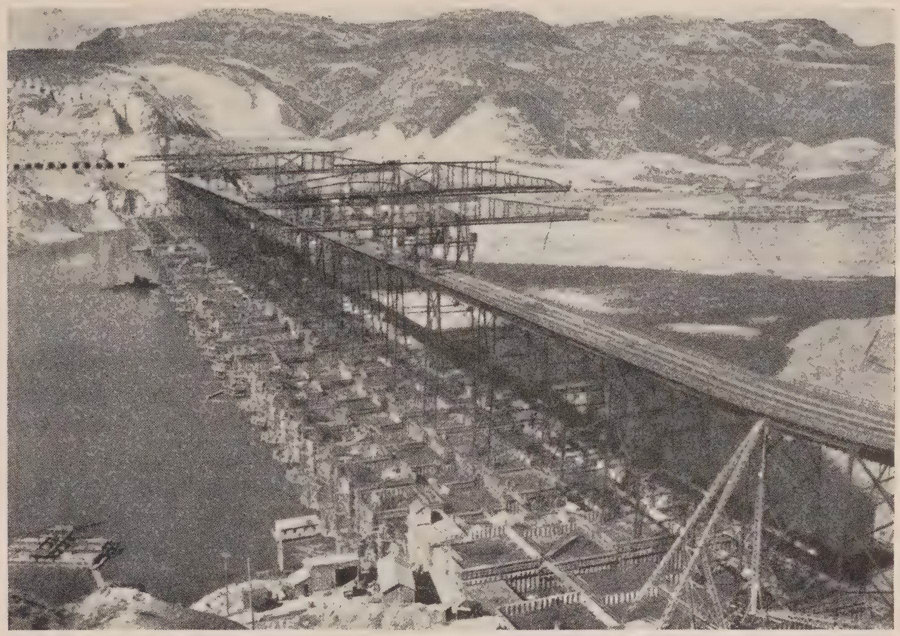
All construction equipment is designed to perform the maximum of work with a minimum of manual labour. Electric shovels and conveyors move 25,000 cubic yards of pit-run sand and gravel in a day. The bulk cement is transported to the dam in box cars which are emptied by a machine which blows the cement through a hose and pipe to the storage for the mixers. As many as 60 cars a day can be handled in this manner. Four mixers of four yards capacity each have established a world record in that 20,684 yards of concrete were poured in a single day. When the dam is completed a total 10,370,000 cubic yards of concrete will have been used.

The water held in check will form one of the largest artificial lakes ever created by the hand of man, extending, as it does, 151 miles up river, to the Canadian border. Storage in the lake will amount to 10,000,000 acre feet, and the elevation of the water will be 1,292 feet above sea level.

If the mass of concrete were permitted to cool naturally it is estimated it would shrink 8 inches in its 4,300 feet of length. To pre-cool and pre-shrink the concrete mass to assure that there will be no future contracting, one-inch tubes are laid approximately five feet apart, extending upward from the base of the dam. When the dam finally is completed, the masonry will hold 2,000 miles of such piping. Cold river water is circulated through the tubing to provide the necessary cooling process to assure correct ripening of the concrete mixture. It is estimated that by the time the dam is completed, heat equivalent to that liberated by the burning of 30,000 tons of coal will have been exhausted by the huge tempering system of water cooling.

The project includes plans for irrigating 1,200,000 acres of land, for which purpose 12 pumps (two being regarded as spares) will be installed. Each pump will have a capacity of 1600 cubic feet per second and will elevate sufficient water to irrigate 120,000 acres of land.

For power purposes provision is made for the installation of 18 turbines each rated at 150,000 horse-



*Construction picture of the dam, irrigation tunnels shown at the upper left.*

power. The generator capacity of each will be 108,000 kilowatts and the ultimate capacity of the electrical plant 1,981,500 kilowatts including three 12,500 kilowatt station service units. Each of the turbines will weigh 1,500,000 pounds and each generator 2,000,000 pounds. These are 30 per cent. greater in capacity than the largest built to date—those installed at Boulder Dam, each of which is rated at 82,500 kilowatts capacity. Water to each of the units will be delivered through an 18-foot steel penstock. At full load the water will enter the penstock at the rate of 141 tons a second. Under this condition, enough water will pass through each turbine in a single day to provide thirty gallons per capita for over 80,000,000 persons.

The work is carried on night and day, seven days a week, 7,000 men having been on the pay-roll at one time. This in turn has caused a population of 15,000 persons in the vicinity of the site.

The project will be a man-built giant, whose power will transmit life to a barren soil, as well as bring convenience to man as an individual and a new prosperity to industry.

# Convention Programmes

THE Annual Meeting of the Ontario Municipal Electric Association and the winter convention of the Association of Municipal Electrical Utilities will be held concurrently at the Royal York Hotel, Toronto, on February 6th and 7th, 1940.

The programmes of the two Associations have been arranged so that there will be two joint sessions, namely, on the afternoon of each day. On each morning each Association will hold its own separate session. They will follow the general practice of meeting together for the convention luncheons and dinner; the luncheon on Wednesday, February 7th, being the regular weekly meeting of the Electric Club of Toronto which the two Associations will attend as guests.

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## Accident Prevention Meeting

On the evening preceding the convention, Monday, February 5th, there will be a dinner meeting at the Royal York Hotel beginning at 6.00 o'clock, arranged by the Electrical Employers Association of Ontario. There will be a number of short addresses on the work of Accident Prevention and also a general Round Table conference. This is a variation from the former practice of having one long speech on a general subject, it being believed that more benefit can be derived by short discussions on a number of subjects than by devoting the evening to one long address. Officers of the Electrical Employers Association and also its Managing Committee will be elected at this meeting.

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## O.M.E.A.

The programme of the Annual Convention of the Ontario Municipal Electric Association has been tentatively arranged as follows:—

Monday—February 5th.

*Evening.*

8.00 o'clock—Executive Committee Meeting.

Tuesday—February 6th.

*Morning.*

Registration.

10 o'clock—Convention Session.

*Afternoon.*

12.30 o'clock—Convention Luncheon with A.M.E.U.

Address by Dr. T. H. Hogg, Chairman, The Hydro-Electric Power Commission of Ontario.

2.30 o'clock — Convention Session with A.M.E.U.

Paper on Public Relations by E. V. Buchanan, General Manager, The Public Utilities Commission, London.

Question Box. The balance of the afternoon will be devoted to answering questions from an organized question box.

*Evening.*

6.30 o'clock — Convention Dinner with A.M.E.U.

Address. (The speaker will possibly be the Honourable M. F. Hepburn, Prime Minister of the Province of Ontario).

Wednesday—February 7th.

*Morning.*

9.30 o'clock—Convention Session.

*Afternoon.*

12.30 o'clock—Convention Luncheon with A.M.E.U. and the Electric Club of Toronto.

Address — "Recent Advances in Radio"—By Dr. W. R. G. Baker, Manager, Radio and Television Department, General Electric Company, Bridgeport, Conn. Dr. Baker will deal particularly with the new system popularly known as Staticless Radio and may also say something about television.

2.30 o'clock — Convention Session with A.M.E.U.

This session will be under the direction of R. T. Jeffery, Chief Municipal Engineer, The Hydro-Electric Power Commission of Ontario, Toronto.

Executive Committee Meeting—The New Executive will meet immediately following the close of this session.

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## A.M.E.U.

The foregoing tentative programme of the O.M.E.A. Annual Meeting outlines the sessions as also the convention luncheons and dinner to be held jointly with the A.M.E.U. In the following outline of the programme of the winter convention of the Association of Municipal Electrical Utilities, the reader is referred back to the Ontario Municipal Electric Association programme for such parts as are to be held jointly and only the details of the separate sessions are listed.

Tuesday—February 6th.

*Morning.*

Registration.

10.30 o'clock—Convention Session.

Reports of Committees.

*Afternoon.*

12.30 o'clock—Convention Luncheon with O.M.E.A.

(See O.M.E.A. programme.)

2.30 o'clock — Convention Session with O.M.E.A.

(See O.M.E.A. programme.)

*Evening.*

6.30 o'clock — Convention Dinner with O.M.E.A.

(See O.M.E.A. programme.)

9.00 o'clock—Executive Committee Meeting.

Wednesday—February 7th.

*Morning.*

9.30 o'clock—Convention Session.

Paper—"Unit Substations"—By C. H. Hutton, Chief Engineer, Hamilton Hydro-Electric System, Hamilton.

Paper—"The Operation of a Large Electric Power System"—By John Dibblee, Assistant Chief Engineer, The Hydro-Electric Power Commission of Ontario, Toronto.

*Afternoon.*

12.30 o'clock—Convention Luncheon with O.M.E.A. and the Electric Club of Toronto.

(See O.M.E.A. programme.)

2.30 o'clock — Convention Session with O.M.E.A.

(See O.M.E.A. programme.)

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## A.M.E.U. Election Ballot

The election of officers of the Association of Municipal Electrical Utili-

ties will take place on Tuesday, February 6th. Delegates will receive their ballots on the morning of that day and up to the opening of the afternoon sessions. Immediately after the opening of this session the ballot will be closed and the scrutineers will report the results of the elections before that session adjourns. The ballots will show the following as candidates:—

PRESIDENT—A. B. Manson, Stratford. (Acclamation.)

VICE-PRESIDENT—C. E. Brown, Meaford, and H. R. Hatcher, Galt.

SECRETARY—S. R. A. Clement, H.E.P.C. of Ontario, Toronto. (Acclamation.)

TREASURER—George E. Conn, H.E.P.C. of Ontario, Toronto, and S. E. Preston, H.E.P.C. of Ontario, Toronto.

DIRECTORS *(from the Membership-at-Large)*—A. W. Bradt, Hamilton; S. W. Canniff, Ottawa; W. R. Catton, Brantford; J. W. Peart, St. Thomas; C. E. Schwenger, Toronto, and P. B. Yates, St. Catharines.

DISTRICT DIRECTORS—

NIAGARA DISTRICT—V. A. McKillop, London, and O. M. Perry, Windsor.

GEORGIAN BAY DISTRICT—R. S. King, Midland, and J. R. McLinden, Owen Sound.

EASTERN DISTRICT—R. J. Smith, Perth. (Acclamation.)

CENTRAL DISTRICT — R. O. Quick, Brighton, and George F. Shreve, Oshawa.

NORTHERN DISTRICT—(To be nominated.)

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